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OF CIVIL ENGINEERS

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Journal of

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CONTENTS

September, 1959

Papers

| | Page |
|---|---|
| Discussion | 1 |
| Methods of Accomplishing Professional Development by N. W. Dougherty | 27 |
| 1959 ASCE Salary Survey Report of the Committee on Salaries of the ASCE Department of Conditions of Practice | 33 |

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Journal of

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CONTENTS

DISCUSSION

Page

Six Thousand High School Students View Engineering and Scientific Careers: Report of the Student Activities Committee, San Diego Section, ASCE. (Proc. Paper 1868, December, 1958. Prior discussion: none. Discussion closed.)
by Committee on Engineering Education, Los Angeles Section . . . 3

Engineering Education As It Affects Unity in the Profession, by Frederick C. Lindvall. (Proc. Paper 1869, December, 1958. Prior discussion: none. Discussion closed.)
by Henry G. Howard . . . . . 7

Pity the Poor Professors?—or Propagate Them! by Jack McKee. (Proc. Paper 1870, December, 1958. Prior discussion: 2042. Discussion closed.)
by Hotten A. Elleby. . . . . 9
by Frank A. Butrico . . . . . 10

Importance of Emphasis in Civil Engineering Education, by L. E. Grinter. (Proc. Paper 1871, December, 1958. Prior discussion: 2042. Discussion closed.)
by C. J. Posey. . . . . 13
by John E. Kiker, Jr. . . . . 16
by Lee H. Johnson . . . . . 17

Sputniks, Flopniks and Engineering Education, by C. Ken Weidner. (Proc. Paper 1872, December, 1958. Prior discussion: 2042. Discussion closed.)
by Alfred C. Ingersoll. . . . . 19
by Frederick L. Hotes. . . . . 21

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# SIX THOUSAND HIGH SCHOOL STUDENTS VIEW ENGINEERING AND SCIENTIFIC CAREERS[a]

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Discussion by Committee on Engineering Education, Los Angeles Section, ASCE

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COMMITTEE ON ENGINEERING EDUCATION, LOS ANGELES SECTION, ASCE.[1]—Several findings of this excellently conceived and executed study were of special interest to the discussers. Overwhelmingly, students planning science and engineering careers indicate that their interest exists primarily because they like science and mathematics classes, and, overwhelmingly, those not planning science and engineering careers are not interested primarily because they like other subjects better than science and mathematics. 25% of the boys in each of the tenth, eleventh, and twelfth grades are interested in science and engineering careers, but only about one-fifth of this percentage of the girls is so oriented. The 25%, however, appears to represent a marked increase in interest. Those planning science and engineering careers felt that the pay and other perquisites of such careers are positive features. The group interested in this kind of career is in the upper stratum of intellectual ability.

It is to be noted that all data of the paper and of this discussion are pre-Sputnik.

## Increasing Interest in Engineering and Science

63% of the 25% of San Diego County boys interested in science and engineering, or about 16% of the total male enrollment, rank in the above-average and presumably college-eligible group. This may be compared with the 36% of boys in all interest categories in the above-average group. If one remembers that college graduations have been about 3/5 men and 2/5 women, it can be projected that total college graduations in a few years will contain around 27% male science and engineering majors. The girls would raise this to perhaps 30%. The 30% may be compared with past national experience, which indicates a figure slightly less than 20%. Does this indicate an increase of interest nationally or merely a geographical variation applicable only to San Diego County schools outside San Diego City?

Surveys by the Office of the Superintendent of Schools, Los Angeles City School System, show a marked, recent upward trend in science and engineering interest. This is illustrated by the following percentages of total enrollment by grade level which are enrolled in the indicated subjects.

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a. Proc. Paper 1868, December, 1958, by Student Activities Committee, San Diego Section, ASCE.

1. Members are W. J. Carroll, D. E. Goss, A. L. Himelhoch, A. C. Ingersoll, J. J. Kesler, F. B. Laverty, J. E. McKee, K. C. Reynolds, and C. M. Duke (chairman).

| | 1956-57 | 1955-56 | 1950-51 |
|---|---|---|---|
| 10th, 11th and 12th grade students enrolled in college preparatory mathematics | 34.6% | 33.5% | 26.9% |
| 11th and 12th grade students enrolled in advanced academic mathematics | 12.5% | 11.5% | 9.3% |
| 11th and 12th grade students enrolled in college preparatory sciences (chemistry, physics, physiology) | 36.9% | | 20.9% |
| 12th grade students enrolled in physics | 13.4% | | 12.6% |
| Enrollment in 10th, 11th, and 12th grades | 66,800 | | 53,600 |

Statewide figures for California, just released by the Department of Education, showed the following enrollment increases for 1956 over 1951: in beginning algebra, from 49.4 to 59.3%; in plane geometry, from 33 to 40% (sophomores); in chemistry, from 25 to 30% (juniors).

These three sets of data strongly suggest that future California college graduations will contain significantly increased percentages of scientists and engineers.

If these California data are representative of the country, four broad questions are raised. Will the increased percentage output of scientists and engineers balance the demand? Can the needs of the other college-based vocations, law, theology, non-science teaching, journalism, etc., be met if engineering and science absorb such a markedly increased fraction? Can the colleges of the country handle the shift in curriculum at the same time that they must double their plants and faculty to take care of the increasing total numbers? How sensitive is the fraction to shifts in national and international political climate?

It is to be noted that the data of both the paper and this discussion are pre-Sputnik. 1958 figures may show an acceleration of the increase in interest.

Motivation

The findings of the paper strongly support the rapidly developing practice of emphasis on the junior high school and elementary school for career guidance. The percentages interested in science and engineering did not change appreciably from the tenth to the twelfth grade. Excellent and inspirational teaching of mathematics classes in the early school years is of extreme importance, and the teacher is seen as central. However, these qualities of instruction must be maintained throughout high school and college in order to sustain interest. Could not more be done to interest girls?

Much is being done but much more can be done by the engineering profession to help science and mathematics teachers strengthen instruction and motivation. The newly organized Industry-Education Council in Southern California is a good example of how the efforts of the schools and the profession can be coordinated and mobilized. It is very probable that the efforts

of the profession have been instrumental in achieving the increased interest already noted.

## Guidance

In general, the students were satisfied with their knowledge of their chosen field, but they expressed a desire to know more about other fields. Cross analysis of the questionnaires showed that the students did, in fact, know the general, factual information about their chosen vocation.

The discussers are familiar with the career guidance program of the Los Angeles City School System and are much impressed with its quality. Standardized intelligence, aptitude, and achievement tests are given to all students and this information is used by professional counselors in the guidance effort. The school system has published two excellent volumes of career guidance data, which are studied by students at all high schools; one volume is studied by twelfth grade students and one by tenth grade students. Booklets like "You Can be a Civil Engineer," which was distributed by ASCE in junior high schools throughout the country, have been found extremely helpful to students and counselors. The cooperation of the school system in the San Diego area with the engineering profession in connection with guidance, as described in the paper, is typical of activity going on all over California. In addition, nearly all high schools conduct guidance programs including "college nights" and "career days" in which they invite appropriate outside speakers to talk with small groups of students and parents.

The long range trends in industrialization both in the United States and throughout the world imply a steady, long range demand for more and more engineers. Transient non-shortages may occur, but technological education will prepare graduates in these periods for a broad spectrum of vocations. Further, a temporary oversupply of engineers may be in itself a force which will accelerate technological advance.

## Need for Teachers and Schools

Something like 8000 new college teachers in engineering and science will be needed in California alone in the next twelve years. The number required to teach science and mathematics in the lower schools may be added to give a feeling for the enormity of the future growth of the educational phase of engineering and science, which will surely include an upsurge in their contribution to general education. It seems very likely that there will not be enough such teachers for many years. It is not our American way to deny their choice of education to qualified students, no matter how great their number.

ASCE urged action on the coming problems of quantity and quality of teachers in their request to all local sections as mentioned in the paper. The data of the paper help clarify the job to be done, and suggest at least one area for action: the fair sex.

"The percentage of girl students showing a preference for occupations in the scientific and engineering fields started at 5.7 per cent in the sophomore year, decreased to 4.0 per cent in the junior year, and 3.5 per cent in the senior year." This may be compared with the 25% of boys in each year. A recent survey of girl mathematics majors at U.C.L.A. showed that they had progressed in their field despite great negative social pressures. Is there not in the girls a great potential for teachers of mathematics and science as well as practicing scientists and engineers? The terms "engineering", "mathematics," and science" are neuter. Can't we find ways to remove the stigma

of masculinity from the terms "engineer," "mathematician," and "scientist"?

School and college plant needs in the next twelve years will grow at least in proportion to the teacher needs. With student interest shifting toward science and engineering, the college plant costs will be correspondingly enlarged due to the high costs of technical instruction.

Total annual costs per student for Los Angeles schools have been increasing rapidly, but up to now not markedly in excess of increases in assessed valuation. However, the well known upsurge in birth rate will have 23% of the Los Angeles population in school in 1965 compared with 15% in 1950. One new school will have to be added each week for the next fifteen years in the metropolitan area. Los Angeles citizens as well as the citizens of all American communities will have to solve unprecedented financing problems.

A Bouquet

The San Diego Section Committee on Student Activities has shown vision and tenacity in making this important contribution to progress in engineering and scientific education. The discussers have only scratched the surface in suggesting inferences from the findings. We commend to all engineers a careful study of the paper with a view to application of its results in their communities.

# ENGINEERING EDUCATION AS IT AFFECTS UNITY IN THE PROFESSION[a]

Discussion by Henry G. Howard

HENRY G. HOWARD,[1] F. ASCE.—The writer has read Mr. Lindvall's paper with much interest and believes there is much food for thought for the profession in it.

Particular notice was taken of the third paragraph of the paper and it is believed that the statements made could be of much more value to the profession and give a feeling of greater pride in our calling if we call ourselves professional engineers rather than just plain engineers. The specialist designation may well be second in our thinking and attitudes, but in first place we must be professional engineers and not merely engineers.

Psychologically the titel "Engineer" does not have, in the writer's opinion, the greater appeal, rather than the narrower designation mentioned in this paper. To all too many people the title Engineer means the man who runs the power shovel on a construction job or the man who operates a locomotive on the railroad. This may be sad but it is true and the fact that it is true is largely our own fault. To the writer the title which should have the greater appeal psychologically or any other way is that of "Professional Engineer."

If, in Mr. Lindvall's analogy to the medical profession, an engineer is ethically and legally qualified to list himself as "Robert Smith, Eng. or John Roberts, Eng." it is assumed that he is a registered engineer licensed to practice his profession. Therefore, he should list himself always as "Robert Smith, P. E. or John Roberts, P. E." followed by any terms of specialization that he may desire.

To some, the above discussion may seem to be "just quibbling" but to the writer it is far from it and this matter of designation should be taken very seriously by everyone of us. It is the duty of every engineer who is at all interested in or takes his profession seriously to speak up whenever he thinks he sees any way to elevate or enhance the prestige of his profession.

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a. Proc. Paper 1869, December, 1958, by Frederick C. Lindvall.

1. Chf. Bridge Engr., Southern Div., Michael Baker, Jr., Inc., Jackson, Miss.

# PITY THE POOR PROFESSORS?—OR PROPAGATE THEM![a]

Discussions by Hotten A. Elleby and Frank A. Butrico

HOTTEN A. ELLEBY,[1] A. M. ASCE.—In essence, the writer agrees with most aspects of Mr. McKee's paper. However, the report understresses one of the most critical phases in the development of our future crop of educators. This is the period during which the advanced degree is being obtained, and during which professional status is usually not recognized. This phase is usually from 3 to 7 years in length, depending on the amount of time per year which is spent on the realization of the advanced degree. The income to be expected during this period will usually be considerably less than received by his counterpart in industry. This is also the phase during which a person thinks of getting married. Three of the most vital elements of a person's life are being sacrificed: money, time and a natural home life.

The graduate student during this phase must have monetary subsistance. This will usually consist of an assistant teaching position, an instructorship, a research grant, or even a working wife. How many can work full time at these positions and still expect to attain a degree in a reasonable amount of time? It therefore follows that the larger the fraction of full-time work, the larger the amount of time needed to acquire the degree. Sometimes even a leave of absence must be taken to expedite this process. How many persons can afford to live on these part-time salaries for this period of time, or still, how many would care to live under these conditions for this length of time?

We must face another fact. This is a materialistic world in which we live, where high living standards are not only the rule, but something which every one naturally desires. The argument, therefore, is why should these standards be foregone especially in those years during which some of these standards mean the most. This is, of course, a very mercenary argument, but, nevertheless, these are the problems which enter into any discussion relating to the possibility of embarking upon a career in education. It is not until this monetary factor is removed that men will be attracted to the profession.

It can be seen that during this period of time, there will be little time for enjoyment of avocations. Leisure time will be so rare that any semblance of a natural home life and social life will be impossible. This is especially true in the case of a full-time teaching load coincident with graduate work. This cannot be said of his counterpart in industry.

The argument will be made that the goals to be reached are well worth the time, effort and income sacrificed in attaining them. Even if this is so, how many undergraduates would be farsighted enough to see this? How many would be willing to put their families and themselves through this trial? Also, when

a. Proc. Paper 1870, December, 1958, by Jack McKee.
1. Inst. of C. E. Mich. State U., E. Lansing, Mich.

the Ph. D. is received, it is not necessarily the magic formula which solves all problems.

There is one more factor to bring into the discussion. When the person does not continue in this field, will the degree and/or the experience gained in these years be of benefit to him in competing with his industrial counterpart (especially beyond the M.S. degree)? I think that the consensus of opinion is a negative one. This is almost unanimous amongst the group we are considering. This is not a positive inducement to enter into the teaching profession.

Perhaps it is time that the educational institutions take a more liberal view concerning the monetary policies applied to the graduate teaching staff. It might be better if there could be devised a system in which the graduate student could complete a full year of academic studies while at the same time carrying a full year's teaching salary. This would, by the laws of supply and demand, produce a greater amount of people who would be willing to enter into the teaching profession. This is the same policy that is followed in industry when it is desired to train their personnel for more advanced positions.

FRANK A. BUTRICO,[1] F. ASCE.—Professor McKee's description of the oncoming avalanche of college students and of the increasing need for young engineers to keep turning the wheels of our developing technology is well taken. We will be getting more students and we do need more and better qualified engineering faculty.

In a tentative analysis made by my own unit in the U. S. Public Health Service of the need for sanitary engineers in coming years, it was estimated that some 900 sanitary engineering graduates would be required per year for the next decade. This compares with the less than 150 currently being annually produced.

Professor McKee's income figures are corroborated by data from a recent survey conducted jointly by the National Science Foundation and the U. S. Public Health Service a few years ago. This survey of sanitary engineers eventually encompassed the returns from some 4,500 sanitary engineers, a group estimated to represent at least two-thirds of the known engineers engaged in this specialty throughout the country. My office prepared an analysis of the data. A median income (from principal employment) of $6,600 was reported for those respondents who were college or university teachers. This compares with the median income of $8,400 representing all the respondents in this study. Almost half the teaching respondents also reported additional income from professional activity ranging from $1,000 - $5,000. If, as Professor McKee suggests, one-third of the faculty man's base pay may be added as coming from "other activity," the higher median of $8,800 ($6,600 + $2,200) for teachers in this particular survey matches his own stated figures very well.

It must also be agreed that additional financial incentives are required to attract and keep the best brains on the campus breeding more engineers. The U. S. Public Health Service has made modest efforts and contributions in this regard. The Division of Sanitary Engineering Services makes regular use of engineering consultants in such fields as water pollution, atmospheric pollution, and radiological health hazards. The Division also hires faculty people

1. Chf. Eng., Resources Program, Div. of Eng. Services, Public Health Service, U. S. Dept. of Health, Education, and Welfare, Washington, D. C.

during summer months for a variety of survey needs in these same areas. Public Law 911 includes a traineeship program which provides graduate training opportunities for young people interested in advanced degrees in the public health field. Sanitary engineers have been eligible and increasing numbers have taken advantage of this program. The stipend provides a higher sum than is usually made available by the college or university. It is $3,000 plus $350 for each dependent, as compared with the frequently $150 per month available at the university for research assistantships. This traineeship program serves as one means of bringing talented young engineers close to the attractions of the teaching profession.

A word of caution must be presented. As important as it may be to provide the engineering educator with professional income in addition to his academic salary, the danger is ever present that such activity will detract from the educator's time and efforts which in the first instance should be obligated to the student. Professor McKee states that "some professors are quite reluctant to seek outside work." Though I heartily concur in the strategic role played by adequate financial remuneration, it must be recognized that academic salaries will never approach those of private enterprise, and that many engineers teach because they prefer the relative quiet of campus life and genuinely enjoy nurturing young and eager minds. In any case, the solution is obvious: society should be willing to pay for the material comforts so abundant in our lives and to which engineers have made vital contributions. The public must also be made aware of the fact that of all the resources which are non-renewable, the most precious—human talent—fortunately is renewable. With this recognition will come greater status to educators and with such status will come adequate base pay for services rendered.

# IMPORTANCE OF EMPHASIS IN CIVIL ENGINEERING EDUCATION[a]

Discussions by C. J. Posey, John E. Kiker, Jr. and Lee H. Johnson

C. J. POSEY,[1] F. ASCE.—The author analyzes the reasons why the civil engineering profession has fallen into a position where different groups, junior grade civil engineers and deans of engineering, feel that civil engineering is less attractive and less highly regarded than other branches of the profession. The writer would like to point out a fundamental difference in the way in which the branches of engineering function with respect to society at large. Consideration of this difference and of another important factor which seems to have been neglected by educators may show that the relative position of civil engineering is inevitable, or, on the other hand, it may indicate that a change in civil engineering education, if in the right direction, might indeed affect an improvement.

Each branch of the engineering profession is in the business of selling its services to society. The return depends upon two things; the quality of the services rendered and the amount of effort expended in selling those services. Neither can be neglected if the business is to prosper.

Now let us assume that a young mechanical or electrical engineer develops a gadget that is useful in the household. If it is as much as two or three times as good as its predecessor he can patent it and sell it without too much trouble. Then if he can keep ahead of his competitors technically, production of his device may grow into a multi-million dollar industry. The industry now has a great sales force. True, it may have a large engineering staff busy inventing, developing, and manufacturing, but the sales staff is still larger and it includes very few engineers. The selling of automobiles, automatic washing machines, or television sets does not demand engineering training. Specialists in selling can be employed, and there is no danger that emphasis on selling will be neglected. Unless it gets too cocksure, this vast army of salesmen is aware of its dependence upon the engineer back at the factory and the research worker in the company's laboratories.

Contrast this with the position of the young civil engineer trained to design and build highways, bridges, multi-purpose dams or other public works. Work cannot be seriously started until the project is sold, this time not to individuals who can be overwhelmed, one by one, by hundreds of thousands of salesmen, armed with every trick of psychology, not to mention the glittering gadget itself, demonstrable and within grasp; but to the tax-weary public by a few "promoters" who have only paper plans to show, and who must work through a "lobby" to convince the public's representatives. I suspect that the young civil engineer is often just as capable of making a significant improvement as the

a. Proc. Paper 1871, December, 1958, by L. E. Grinter.
1. Head, Dept. of Civ. Eng., Univ. of Iowa, Iowa City, Iowa.

electrical or mechanical engineer, but he has a much smaller chance of being able to demonstrate this on his own.

What is the remedy for this situation? Obviously, the cards are stacked against us and will remain so. But certainly there will be some improvement if the civil engineering profession will train its own salesmen and put a proportionately greater share of its effort into sales. The stigma often attached to sales work by civil engineers must be removed, since sale of our profession's output cannot be accomplished by non-engineers, as can much of the electrical and mechanical engineers'. In this connection it should be noted that while engineers are not necessary to sell television sets and automobiles, very competent engineers are needed to sell electrical and mechanical equipment for industrial applications. As in the case of the technical representatives of some of the industry associations active in the civil engineering field, however, too much of this talent goes into getting one product used instead of another, on projects that have already been "sold".

It is not just sales effort in the narrow sense that is needed, but in the broader sense, in the public relations field. Now it is possible that our education system, aimed at producing designers and research workers, automatically eliminates the sales talent that we need. By its narrow selectivity, it may also be robbing the profession of other badly needed abilities which might enable us to do a better job.

What may be largely responsible for this situation is a popular misconception among educators; the idea that native ability is a scalar quantity, one having magnitude only. Casual acquaintance with variability of student performance leads to this fallacy. It is only natural to conclude, when one finds many students who excel in almost every way that you can test them, and others who do not seem to be able to perform well, no matter what you try, that the most important characteristic of the student population is this tremendous variation of a single variable, "intelligence". If unevenness does crop up, it can be explained on the basis of accidental differences in prior training or individual interest. Real native ability is assumed to be something basic, and the fact that negative correlations are found with respect to certain abilities reflects those accidental differences or some yet-to-be improved imperfection of the I. Q. tests. Or, if there are exceptions, they are rare and unimportant. Even if intelligence is conceded to be non-scalar, it is often conceived to be only slightly non-uniform. Abilities in one direction may be somewhat above average, while those in another are slightly below average.

Actually, both of these views are inadequate. If intelligence or mental ability can be represented by anything as simple as even a vector function, it is an amazingly complicated one. Despite the most intense motivation, the brilliant geometer may be inept at algebra, or visa versa. One student who is able quickly to master the intricacies of indeterminate structure analysis is unable to do the type of thinking necessary to design simple structures, while another who has a superb sense of proportion cannot master the idea of a free body diagram.

To those who think such tremendous imbalance so rare as to be unimportant it should be pointed out these individuals, who have a thousand or more times the ability for a certain type of activity than another that might seem to be closely related, often turn out to be those who make important contributions. Moreover, it may be the rule rather than something rare or uncommon. Dr. Roger J. Williams, director of the Biochemical Institute at the University of Texas, writing in the Spring 1959 issue of the Wiley Bulletin, describes this phenomenon as follows:

"On the basis of what we know about brain variation, one might suppose that there would be distinctive patterns of thinking just as there are distinctive individual endocrine patterns and metabolic patterns.

"If this is so, minds cannot be adequately classified as 'poor,' 'mediocre,' 'good', and 'excellent'. There are, indeed, many aspects of mental ability as Thurstone demonstrated. There are verbal factors, memory factors, arithmetical factors, spatial imagery, etc. and an individual who is excellent in one area, may be mediocre in another and vice versa. Guilford has recently concluded that there are not less than forty different facets to one's mind. If this is so, the patterns of mental abilities are highly intricate.

"Recently it has been appreciated more fully than ever before that creativity is something which may be possessed by an individual, whether or not he is unusually able as judged by comprehensive mental tests. In other words, the superb 'lesson getters' are not necessarily endowed with creativity. This is a fact which is very often, if not generally, overlooked in 'talent searches'. The students who are most often sought out and rewarded are those that make 'A' in every subject. These may turn out to be 'duds' so far as creativity is concerned."

Knowledge of differences in the individual ability vector is not as modern a bit of wisdom as Dr. Williams implies. "Did ye never read in the scriptures; The stone which the builders rejected, the same is become the head of the corner."

It would seem, therefore, that the educator's job should be to tailor the education to fit the individual rather than to throw out every individual who does not fit well into every last corner of a prescribed curriculum designed on the basis of speculation as to what he will need in his future work.

Practically, how is this to be done? It is obviously impractical to have a highly skilled tutor for each three or four students. A change can be made in this direction, however, by having a more flexible curriculum, and by giving more attention to advising at enrollment time. More reliance can be placed on student judgment, in this connection, than is ordinarily supposed. Some care must be taken to prevent large numbers of students from flocking into "pipe" courses. Even this may not be so bad, however, for the facts tend to become widely known. The more able and serious students do not look for easy courses, but for valuable ones.

By the time a student has finished calculus, he and his instructors should be able to determine whether he should go on to differential equations or statistics, or perhaps abandon mathematics and take cost accounting, ethics, or public speaking. If he has little talent for mathematics, it is wasteful to make him go further. If he is required to go on, his advanced mathematics instructor may be a wise enough man to see that he has other talents which will be valuable to the engineering profession, and let him through with a barely passing grade, but it would certainly be better both for him and for the mathematically gifted students if he were permitted to take courses which would improve his ability in more promising directions.

The engineer requires both knowledge and skill in its practical application, and it seems that at present it is the latter element that is deficient. Improvement will come more from teaching application courses in the proper manner than from giving the basic sciences more time to impart knowledge. In the writer's opinion, the civil engineering profession's chances of rendering

more and better service to society are greater by this route than by merely revising rigid curriculum requirements.

The writer certainly agrees that a change from teaching "art" to teaching "skill" is needed, but it is by no means certain that this will be brought about by changing the required courses in the curriculum. The instructor in differential equations, anxious for his section to do well in the departmental examination, may teach the bag of tricks necessary to dispose of the types of problems likely to show up on the examinations, and hence be teaching largely "arts", while the Surveying instructor may let his students develop original approaches to a variety of problems, with only minor emphasis on practice, and be teaching "skills". Even sandbagging and riprap can be approached in such a way as to yield "skills" training rather than "arts" instruction.

It is at precisely this point, the practical application of basic scientific and mathematical knowledge for the benefit of mankind, that the engineer makes his unique contribution, and here must be the most important part of his training. "All knowledge" and "no application" add up to "no engineering", just as deficient, if not more so, than "no knowledge" and "all application".

JOHN E. KIKER, Jr.,[1] F. ASCE.—As has been emphasized by Dr. Grinter, knowledge of construction arts and practices suffers from an extremely high degree of obsolescence with time. As he indicated also, knowledge of engineering science, analysis, and design have a much greater transferability; and it is believed that sanitary engineers generally will subscribe to his inference that direct action is needed to improve the situation that exists in most engineering educational institutions. For one thing, it would probably be easier to attract more young men to sanitary engineering if they had a background offering a greater degree of transferability than is presently offered in ordinary civil engineering curricula.

It is doubtful, however, that the practicing consulting engineer or some of the public agencies employing graduate engineers will be so readily convinced. The practicing engineer who has to meet his payrolls regularly will probably continue to insist that the young graduates have a reasonable knowledge of engineering arts and practices, and it is thought that all engineers should have a basic knowledge of economics and finance.

As regards civil engineering teachers, there certainly needs to be a balance between interest in civil engineering practice and interest in pushing back the frontiers of knowledge. But care should be taken to see that the pendulum does not swing too far. According to this writer's recollections, his best teachers—the ones who have not long since been forgotten—were those who taught from sound, practical, engineering experience. They were the ones who best seemed to know what frontiers needed to be pushed back. They were the only ones who were capable of stimulating real interest; and they were the only ones whose teaching had virility and the ring of authority. This is not to decry the need for theoreticians without practical experience, nor is it meant to belittle the importance of more courses in engineering science or courses with a greater degree of transferability. The latter are needed especially for graduate students and teachers of graduate students who are the ones most likely to push back the frontiers. In this connection, some institutions offer sanitary engineering only at the graduate level, and there is much to be said

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in favor of this policy. On the other hand, some employers actually prefer engineers who have not had graduate work; and others prefer them to take their graduate work after they have had a few years of practical experience. One such person is the Director of the Bureau of Sanitary Engineering, Florida State Board of Health. He claims that those who have graduate degrees expect to become "chiefs" in too short a time, and that what he really needs is more "indians." Lest there be some misunderstanding, the "indians" to which he refers are not mere "technicians." They are engineers-in-training, who will qualify for full professional registration after four years of experience, and they include men who will be reviewing and correcting engineering plans submitted by professional consultants throughout the state.

One final point. Of all the courses available in college, few have more transferability of knowledge than Bacteriology or Environmental Sanitation. Every individual has some potential concern with both subjects every day of his life, whether applied to the water he drinks, the food he eats or the baby's bottle he prepares; yet neither of the courses is required in many engineering curricula.

LEE H. JOHNSON,[1] F. ASCE.—Dean Grinter has presented a number of thought-provoking comments in this paper. One of the most striking has to do with what he calls the obsolescence factors of knowledge. I must agree with him with regard to the problem created by teaching knowledge which rapidly becomes obsolescent.

Part of the problem in civil engineering may be due to the fact that many employers of civil engineers expect fresh graduates to take immediate responsibility for work using the same procedures and techniques which have been followed for many years. A large percentage of civil engineering graduates start with consulting firms, contractors, or government agencies, most of which have little if any training programs which provide a transition from engineering school to practice. Consulting firms are generally not large enough to provide substantial training programs. Contractors are generally too busy and too rushed meeting time commitments and submitting bids for new jobs. Government agencies would probably have difficulty in obtaining tax monies for educational programs within their organizations. Accordingly, it appears that a larger percentage of civil engineering graduates than of any other group of engineering graduates is expected to shoulder a high degree of professional responsibility soon after if not immediately upon graduation.

In contrast, a larger percentage of chemical, electrical, and mechanical engineers go to work for major industries than for any other group of employers. These industries have sufficient resources and large enough organizations to provide training in the particular techniques and procedures of each industry prior to assuming responsibility for professional work.

This writer believes that there is considerable ferment among civil engineering educators. Some are reacting favorably to the idea of reducing the emphasis on the art of civil engineering practice and giving more attention to basic and more transferable knowledge. Such knowledge does not mean purely mathematics and science. It includes for example limit design, prestressed concrete, engineering materials from the solid state approach, compressible fluid flow as related to pressures upon a variety of structures, nuclear

1. Dean, School of Eng., Tulane Univ., New Orleans, La.

radiation as it might be applied to the measurement of fluid flows, the destruction of bacteria in sewage, or radiation shields, and electronic computers which make possible the solution of many problems in civil engineering hithertofore much too complex to attempt. Much of this knowledge remains yet to be developed through research and there should be more encouragement for such research both from within and without the schools of engineering.

Furthermore, the writer believes that the fears expressed by many educators and professional engineers that civil engineering curricula may become strictly scientific and mathematical to the exclusion of any engineering will not be realized. Such purely scientific curricula represent an extreme swing of the pendulum in the other direction. This is too drastic and too unrealistic to occur.

However, it is reasonable to think that the apparent lack of interest in civil engineering among students coming to college is due partly to preserving the status quo in civil engineering curricula. But there is still the plain fact that any unusual achievements in building design, bridge construction, foundation development, or river hydraulics do not have the same glamourous appeal to young men in general as do rocket fuels, supersonic aircraft, automatic electronic controls, and many other developments which involve things that explode, move at lightening speed, perform mysteriously, or orbit through space. This situation is aggravated by the ever-increasing number of opportunities and demands for electrical and mechanical engineers, for example. Witness the appearance of a host of new industries, large and small, which have sprung up in the wake of nuclear, electronic, and rocket developments. It seems almost trite to say at this time in our history that more scientific research and more use of scientific discoveries and tools are needed in civil engineering if it is going to attract an adequate number of superior students. Civil engineering must become identified with the space age, but certainly in its own way. More publicity to this end is greatly needed. One step in this direction has been made in publishing the pamphlet "Your Future in Civil Engineering" prepared by the ASCE Committee on Engineering Education, which includes a section entitled "Civil engineering in the atomic age." It also discusses new and exciting areas of development in the last section, "A profession with a future."

In closing, the writer wishes to state that papers such as Dean Grinter's are greatly needed to provoke thought and to stimulate educators and professional engineers to seek new ideas and improvements in civil engineering curricula and civil engineering practice. However, he does not believe that the pendulum is likely to swing completely to such an extreme that the profession of civil engineering will one day find that it must call upon pure scientists to solve its problems.

# SPUTNIKS, FLOPNIKS, AND ENGINEERING EDUCATION[a]

## Discussions by Alfred C. Ingersoll and Frederick L. Hotes

ALFRED C. INGERSOLL,[1] F. ASCE.—Dean Weidner makes so many admirable points in this paper that it is difficult to find an opening for critical discussion. The writer, having spent a most instructive year in engineering education work in India (1954-55), offers a hearty endorsement to Dean Weidner's principal arguments for America looking at herself more realistically and toughening up education in general and engineering education in particular. It is no little shock for an American professor to go with his family to a "backward" country like India and find that his children, coming out of our best public schools, are significantly behind their Indian contemporaries in the "core" subjects such as reading and arithmetic.

The writer would agree with almost all of the author's ten observations on how thoughtful foreigners view us. His seventh point, however, concerning Americans blaming unpleasant truths about their country's behavior on their government, calls for some defense on behalf of American participants in our various overseas technical cooperation programs. In the writer's experience, at least, such individuals—although coming from no background of professional diplomacy—most commonly defended the position of the United States Government and sought for behavior explanations in terms of eccentric individuals, who could be expected in any free society.

The author's contention that "the Christian concept of life as practiced is based primarily on fear of the hereafter" is, in the writer's opinion, hardly one that would be subscribed to by the great body of present-day Christian theologians, clergy, and laity. The dominant motivation in Christian life is held rather to be love, as outlined in Paul's first letter to the Corinthians. While the writer concedes that fear in some form does play an important part in our social and economic thinking, he would argue that it plays an even more dominant role in the thinking of nations that are predominantly non-Christian.

Dean Weidner's remarks on the evils of specialization in undergraduate engineering education are especially timely. It need scarcely be remarked that he bolsters the stand taken by the so-called "Grinter Report" of the American Society for Engineering Education.(1) The writer would remark further that the author's views coincide with the educational policy of the California Institute of Technology (and that of many other engineering schools). But Dean Weidner is suggesting something more than a broad-based engineering education in drawing his analogy to the medical profession. He is suggesting that we may well consider giving up trying to put any kind of engineering

a. Proc. Paper 1872, December, 1958, by C. Ken Weidner.

1. Assoc. Prof. of Civ. Eng., California Institute of Technology, Pasadena, Calif.

education into four years, rather leaving these first years to the acquiring of a broad cultural and scientific base, on which to build later a truly professional education.

In the past decade there has been increasing clamor for engineering to be recognized as a profession on a par with law, medicine, and theology. And yet, though we would emulate these professions in terms of stature and public recognition, we seem unwilling to pay the appropriate price in terms of basic and advanced education. It is possible today for a man to call himself an "engineer" after he has graduated from a four-year polytechnic college, in which no humanities courses have been offered and in which a standard detailed project in mechanical engineering shop is the insertion of a cotter pin in a castellated nut!

It would seem that a logical first requirement to the establishment of engineering as a true profession is an educational program that involves approximately three years of "Pre-Engineering", followed by another three years of basic engineering education. At the end of this professional stretch the graduate would become a "general practitioner" of engineering, with exactly the same relation to the engineering profession as has the general practitioner doctor to the medical profession. Beyond this, then, the engineer so desiring could undertake intensive specialization in a particular field, such as structures or sanitary engineering.

For the man who does not make the grade to professional engineer, there would be work aplenty at the sub-professional level. The other professions make good use of their technicians and engineering has even greater requirements for technician support behind each professional. As Dean Weidner points out to be the case in Russia, "sound education must be made available to all those who demonstrate that they deserve it . . . and it must continue until they have reached the maximum of their intellectual development . . . As they demonstrate that they are approaching the limit of their intellectual capacity their program is shifted to training and there find their way directly into industry." Such an approach would have great merit, the writer believes, in upgrading the engineering profession in this country.

Dean Weidner refers near the end of his paper to the large amount of money that Congress is giving the President, "supposedly to ensure that we catch up with the Russians." This move, the National Defense Education Act, has fallen on hard times as far as engineering education is concerned. Recent reports indicate that out of 1,000 fellowships for advanced study that were presumably authorized by the act, only 160 have been implemented thus far, and of these only five are in engineering! The matter is currently under investigation and perhaps the second offering of fellowships will include more for engineers. This illustrates the basic truth, however, that we tend to forget quickly the urgency of the situation once we have a few technical successes such as the Explorer and Vanguard satellites. A wide circulation of Dean Weidner's paper will help to keep this urgency before the American people.

## REFERENCES

1. Report on Evaluation of Engineering Education (1952-1955), American Society for Engineering Education.

FREDERICK L. HOTES,[1] F. ASCE.—While Dean Weidner has, in several instances in this hard-hitting article, most ably played "the Devils' Advocate" as he forewarned that he would, he has also invoked for us a wee bit of the "Pow'r of the giftie" referred to by Robert Burns:

"O wad some Pow'r the giftie gie us
To see oursels as ithers see us!"

The author has revealed that on at least ten points of contact, many of our friends have serious, but honest, doubts concerning American ideals, intentions and methods. Of course others do not always see us as we really are, but they must judge us by our actions and our results; they are not mind readers. We should face these issues, and answer honestly to ourselves—are we wrong, or are we not understood? If we are not understood, it is because our actions have not been properly explained, or because those actions have not been correct in themselves. In the struggle for world leadership and respect, good intentions and good planning are fundamental, but they do not assure success—the implementing tactics must be such as to achieve the end desired. This applies not only to the larger theme of the article under discussion—Strategic Problems of the World—but also to the topic of Engineering Education, which is certainly a significant part of the total complex. The writer doubts that any engineer, scientist or educator, would underestimate the importance of producing creative thinkers in the United States, but he is sure that considerable disagreement exists concerning the tactical means of developing this talent.

It is regretted that the paper as published did not contain more specific details as to the "pilot plant" institution for engineering and science that was recommended by the author, and that the uniqueness of the curricula at American University of Beirut was not outlined. The writer would be interested in learning how the author proposes to implement his basic strategy and principles. However, the author has still provided considerable food for thought and comment.

## Quality of American Civil Engineers

The writer has become acquainted with a great many engineers who received their basic education outside the United States. These men came from many different countries in Europe, Asia, the Middle East, North, South and Central America. Some were graduate students in classes taught by the writer for many years at one of the larger engineering schools in the United States. Others were co-workers, while many were executive engineers and directors of well-established firms. The opinion of the writer, based on these contacts and associated observations, is, that the American civil engineer today is unexcelled in overall effectiveness by the civil engineers of any other nation. Although the writer has not met any engineers educated within the past twenty years in Russia, he knows of no evidence, verbal or written, that indicates that such persons are of anything but ordinary ability and achievement.

Having thus made a universal comparison on the broadest possible terms, and while recognizing the limitations of such an evaluation, the writer can only conclude that the net result of American engineering education has been good.

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1. Water Conservation Engr., Development & Resources Corp., N. Y., stationed in Ahwaz, Iran.

The minimum challenge before the civil engineering profession of the United States, including the engineering education specialty, is to meet the needs of the future with at least the same degree of success as has been achieved by those who have brought us to our professional status of today. There is an even greater challenge, a "natural" for the real professional—to do even better—by increasing the ability of, and degree of contribution to mankind by, the engineer, and to thereby simultaneously increase his professional stature. It is at this point that the arguments start. What kind of engineers are needed for the future? How should they be educated and developed?

The Question of Specialization

The author champions "a broad and basic education in engineering", and states his meaning of the term "broad education". The writer concurs in the objective and the definition, but cannot foresee their general adoption by the engineering profession, or by educational institutions, in the United States. There are dynamic forces in action, far more powerful than those inertial forces with which the author has been struggling, which are increasing the demand for more and better specialization. These forces are those of social, political and economic progress. They affect not only the engineering profession, but also law, medicine, science, agriculture, and even business. The more highly-developed a nation becomes, the greater the demand for specialization.

On the other hand, in the presently under-developed countries of the world, the demand is for the all-around person in any profession or field. Such nations have little need for the highly-skilled expert. This is not theory, but the hard truth. An American corporation executive, an electronics expert, a chemical engineer, placed in an under-developed country, will find his specialized talents seldom utilized, but will be continually required to apply his fundamental knowledge of everything. The broader his abilities, the more successful, and the less-frustrated he will become. This applies to an even greater degree to nationals that return after education "outside".

It is the limitation of the human brain that has forced the age of specialization upon us. As the total knowledge of mankind continues to expand, the percentage of that total knowledge that one man can know, decreases. There is so much to be learned in a special field, that in satisfying the demands of the world for expert knowledge in the field, a man knows less, proportionally, of the total. To the writer this appears to be an almost inexorable law of nature. This applies to any field of specialization (as long as the body of knowledge pertaining thereto exceeds the capacity of one human brain to retain it), and the list of examples, such as civil engineering, law, medicine, organic chemistry, inorganic chemistry, colloid chemistry, etc., is limitless. Some engineers must be specialists, else we would not advance technically as rapidly as necessary, but the specialist inevitably loses some of the all-around capability of the general engineer.

While the writer accepts the inevitable growth of specialization, he is equally convinced that there will always be a need and a demand for the person with a good overall knowledge in the traditional fields. The "general practitioner" will always play a vital role. Such a person must have real "depth", as well as "breadth" of knowledge. Such basic "depth" can be acquired only by thorough education in fundamental principles, and by development beyond the college years by studies and experiences no less rigorous or challenging than those experienced by the most dedicated specialist.

Too many think that a broad but shallow knowledge is the mark of the all-around professional. Such a person can rarely meet a complex situation. It should also be noted that a specialist can be so deeply entrenched in his narrow field, that he is almost useless outside it. Both of these types are difficult to utilize in situations requiring competency and adaptability. The author noted his experiences with such persons during his naval and Argonne Laboratory duties. The writer has also encountered similar persons in both military and civilian work, but unlike the author, the writer cannot recall any particular correlation between their educational program and their limited performances.

### Time Required for an Engineering Education

A few engineering schools in the United States have five-year curricula. Some even list a six-year program that is really two years of liberal arts plus an ordinary four years of engineering. Many engineers are acquiring a five-year engineering education by completing a one-year graduate program. Several prominent civil engineers have openly advocated a minimum program of five years for the bachelor's degree. Dean Weidner has a six-year program. However, the majority of engineering students are enrolled in four-year programs, and the longer programs are still far from popular.

The writer proposes that the engineer of the future should have a minimum university program of seven years. The engineering profession has so far refused to satisfactorily explain the fact that it, of all professions, has the lowest educational requirements. No program in architecture can be accredited if it is less than a five-year program; medicine and law require a minimum of seven years, and often eight years; theology requires six to seven years; and any future scientist must complete seven years of study. Engineering needs seven years, not just to keep up with the other professions, but to produce engineers who have sufficient depth and breadth of knowledge to adequately meet the requirements of the world of today and tomorrow. The writer envisions that such a seven-year engineering program would, from the relative standpoints of technical scope versus specialization, more closely resemble an M.D. program, rather than a Ph.D. program.

The four and five year engineering programs will merely produce the technicians of tomorrow, even as the four and five year programs in science cannot produce the leaders in the fields of science.

If the engineering profession and engineering educators will not specify the seven year program now, it will rise in another form. The writer does not wish to predict now the means by which this will be accomplished, but believes that it will inevitably occur.

### University Education for Whom?

The author remarks, "The state colleges and universities must be freed from having to take automatically the graduates of the high schools of the state". There are several states where this freedom already exists, and there is little doubt but that the sheer pressure of numbers of high school graduates will continue to cause more and more state institutions of higher learning to increase their entrance standards. There is an important danger in this trend. We may damage one of the great unique features of American education that is considered throughout the world as one of the Hallmarks of Democracy.

This feature is the opportunity afforded to every citizen of average intelligence, to be able to obtain a college or university education; if the person so desires, and unusual personal circumstances do not prevent. Costs at state universities have been kept low enough so that almost all who desire can "go through college". The number of American men and women who have "worked their way through college", is legion. By this process we have succeeded in having probably the most educated nation on earth, and the writer is still enough of an idealist to believe that, the higher the educational level of the average man, the better for the man, his nation, and for all mankind."

The writer certainly recognizes the necessity of having entrance standards, but hopes that educators and educational administrators will always remain human enough to give the man who appears to be "somewhat below average", the chance to prove, one way or another, his aptitude for college work. The public must do its part by providing the necessary facilities, funds and faculty. America has always been the "Land of Opportunity". It should always remain so. Education is the process of developing the capacity to think, to analyze a complex situation, to cultivate judgment, and to choose soundly. This opportunity should never be restricted in America (as it has often been in Europe) to a fortunate intellectual elite, or any other special class.

Lest the writer be thought solely a champion of "the average life", he hastens to add that he wholeheartedly supports the author's belief that creative genius must be recognized and cultivated. There is no question but that the engineering education pattern today not only fails to provide the exceptional student sufficient opportunity to develop, but often actually slows down his potential progress by insisting he take prescribed curricula and courses at "normal" rates. Creative thinkers are not necessarily geniuses. Who knows how many have never discovered their own abilities due to the frustrating and restrictive climate of the "standard" curricula?

Foreign Languages

Strong recommendations are made by the author for foreign languages, taught as second languages, "to be required from kindergarten on". Presumably this recommendation would apply to all children, and while the writer is not prepared to advocate mandatory foreign language instruction at that age level, he can recognize the ultimate benefits of such a program to the United States and to the entire world, by the resultant ability of Americans to convey their thoughts to other lands, and to really understand people of other tongues.

It appears that English is becoming a universal language—spoken and written. Many might infer from this that there is little reason for the mass of Americans to learn any foreign tongue. But the writer's recent experiences in foreign lands has convinced him that the only way to convey one's thoughts to another people is in their native tongue. It is simply amazing the tremendous response that is generated when even a few simple native words are used in a foreign land. Even though the other person may know some English, the broken explanation in the strange "tongue" often clears up a misunderstanding, or prevents such from occurring. We can never explain ourselves as Americans without knowing the tongue of the other people.

The writer believes that command of a second, third and even a fourth language is even more important to an American who is not a technical person, than to the latter. Technical people can use translations much more readily because of the common language of mathematics and drawings. But the

business man, political or social scientist, has to sell ideas, and ideas cannot be sold unless they are understood. A man trying to do business in another country, and who does not know the language, has something more than two strikes against him. Imagine a foreign businessman trying to compete in the U.S.A. through interpreters. American business is already finding tough competition, at home and abroad, and it would appear only good business sense to really keep tab on the top competitors. An interpreter helps, but can never be one-half as effective as personal understanding.

Far-sighted parents should not be idle if they believe in foreign language knowledge for their children. If the public schools do not offer such opportunity for grade school children, the parents can arrange for instruction by tutor, special classes or records, a few times a week. The writer sometimes thinks that parents do not always demonstrate the courage of their convictions, and take the initiative, and provide their offspring with some of the things the public schools do not offer. This applies also to subjects other than foreign languages. Some forget about the things they advocate, shrugging them off when the schools fail. If it's really important, the parents will provide, or should provide. Those who don't have already succumbed to the lethargy of the "let the schools, scoutmasters, camp leaders, etc. do it for us" attitude, all too frequently seen.

## The Christian Concept of Life

There is one sentence of the author with which the writer must state his positive disagreement. It is,

> "One cannot deny that the Christian concept of life as practiced is based primarily on fear of the hereafter; and one cannot deny that fear in some form dominates our lives in the United States."

Two concepts of fear are expressed in this statement, and the writer denies that either is fundamentally true. He does not deny that the statement may correctly apply to some people, nor that every mortal man at sometime does not at least temporarily succumb to fear in one form or another, but he can never agree with such a negative, fatalistic, and dour belief, nor agree that the vast majority of the people of the United States so believe. If the people of the United States ever yield to the power of fear, then all hope is lost; all our works, all our words, are indeed in vain, and we labor only to delay an inevitable chaos of gloom and death.

While a technical journal is perhaps not the most appropriate place to state religious beliefs, the writer feels that the principles of Christianity have been made such an integral part of the author's theme that a Christian layman is not out-of-line in commenting thereon. The great message of life as presented in the Christian Gospel is a positive one, not a negative one. It is the reward of the love of the Father that drives the real Christian—not his fear of the consequences if he does not follow.

To give an earthly analogy, consider the case of an American family; the kind of American family that most people would consider normal. What is both the binding and the driving force of the happy family? The answer is—love. It is the reward of the love of the parents that brings the very best from the children. To be sure, when they are children there are many occasions when the emotion of fear must be used to teach them. Children learn that to disobey, means consequent punishment. They obey, and learn love and respect. When they are mature, it is the possible loss of the love that they fear

more than the punishment that may no longer even exist. Yes, fear does play an important part in the life of a family, but would anyone say that fear dominates the happy family? Quite the contrary—in any family dominated by fear, one can find little happiness, and little success. Unless love prevails, life is not good.

So too, with the mature Christian; he understands the place of fear in his life, but he is dominated by the positive power of the two great commandments.(1) It is this positive approach of Christianity that the Communists can never understand, and which they can never extinguish. They have never been able to do so in any country, including Russia, and it baffles them. The Christian has no fear of the hereafter, but the Communist has no hereafter, and this latter is a weakness, not a strength. If the Communist enjoys life he will not look forward to leaving it, to go forth into an empty eternity.

The Future

The author's two concluding paragraphs reveal his faith and positive approach to the future. He has performed a service to all Americans by his "agonizing reappraisal" of some of our fundamental concepts of world life and education.

REFERENCES

1. Mathew 22:34-40, Mark 12:28-34.

Journal of
PROFESSIONAL PRACTICE
Proceedings of the American Society of Civil Engineers

# METHODS OF ACCOMPLISHING PROFESSIONAL DEVELOPMENT[a]

N. W. Dougherty[1]

## SYNOPSIS

A professional is one who uses specialized knowledge and skill in the solution of problems which cannot be standardized. He is actuated by a service motive; he works in a relation of confidence, and he observes an acceptable code of ethical conduct.

These qualities are acquired in the home, at school, and on the job in industry. To grow, the atmosphere and climate must be professional, the teacher and supervisor must be professional; they both must be interested in the growth of the student and worker. Formal instruction is desirable both in school and in industry.

Professionalism is a way of thinking and living rather than an accumulation of knowledge and power. Knowledge and power are essential and when actuated by the professional spirit they produce the leaders and torchbearers.

## INTRODUCTION

The word professional has been bandied about with many meanings in our generation. To the AAU it means an athlete who uses his knowledge and skill for personal gain; to the college football coach it means the members of the opponents team; to the public at large it may mean any one with enough skill in his activity to receive money for doing it. The range may be from the barber to the physician, or from the saxaphone player to the leader of the orchestra. For the purposes of this paper, the meaning will be restricted to a more specialized group identified by distinguishing characteristics which separate its members from all non-professionals.

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a. Presented at the May, 1959, ASCE Convention in Cleveland, Ohio.

1. Dean Emeritus, Univ., of Tennessee, Knoxville, Tenn.

After much travail, many mistakes and a longing "for service to the people," three professions came into the last century bearing the title of "learned professions." They were law, medicine, and the ministry, and after a fashion, they deserved to be called learned. Many of the practitioners of each group had made formal study of the principles involved in their work; they had gone to college. Other groups, as they developed formal educational preparation for their activity, were admitted to the learned groups. There was no formal initiation; no formal presentation with a charter, but rather an assumption of status by the group itself. Usually the doubters about professional status belonged to the group, and they were the most difficult to convince of all. Usually, the public takes a group at its own estimate of itself.

## A Professional

Professional titles[1] should be limited to those persons who apply a body of specialized knowledge and skill, usually acquired by formal college education, to the service of the people. They exercise discretion and judgment; they work in a relation of confidence; they observe an acceptable code of ethical conduct, and band themselves into groups for the improvement of their work. They have legal status and the present tendency is to use this status as the badge of professionalism.

The knowledge and skill is quite different from that of an artisan who can handle tools, equipment or operations; the knowledge is a series of principles which may be applied to many different problems, while the skill is the art or the procedures which have been proven by much doing. Certain professionals are always seeking for new knowledge, new methods and new devices which may promote the application of their methods to new problems. The neophite must spend many years in acquiring the needed knowledge to perform with requisite knowledge and skill.

"Service to the people" is a characteristic of all professionals. Dr. Wickenden illustrated the meaning in his classic article "The Second Mile". His thesis was: "If one compel thee to go one mile, go with him twain." It represents the over and above service, the heaped up and running over, the voluntary mile. It demands enough work to get the job well done, no matter what the compensation.

Discretion and judgment also connotates independent judgment and service. It is the choice of alternatives, the selection of methods, the determination of amounts. It is not routines which may be performed over and over again. It is the type of judgment which is the same for buyer and seller, labor and management or government and citizen. It is determined by the facts and principles and not by the expediency of the moment.

The relation of confidence is a key to professionalism. It is the relation of the doctor to his patient, the lawyer to his client, the minister to his parishioner and the engineer to his employer. Some have suggested that an engineer is not called upon to exercise this relation, and he, therefore, lacks one element of professionalism. He is in a relation of confidence to his employer, to the public and to all who use his works. A city may depend upon the excellence of his water supply, the traveling public may depend upon his bridge, and the whole city, state or nation on the purity of his products. He stands in for his employer; he is the guardian of the public health and public safety.

1. Your Approaches to Professionalism, N. W. Dougherty, published by ECPD.

All professionals adhere to an acceptable code of ethical conduct. Since they must take actions in confidence, they must treat their patient, client, parishioner or employer as they would treat themselves. Their responsibilities are such that they must assume this relation.

Usually professionals band themselves together to improve their knowledge, their methods of performance, and to learn new skills and procedures. They do not form pressure groups to get advantage for themselves, but rather they form groups in order that they may render "better service to the people".

## May These Things Be Taught?

The topic is accomplishing professional development. To describe a product or a personal quality and not be able to produce it or acquire it may be of little benefit. If a characteristic or a quality may be identified and described, it may be taught to all who will learn.

First and foremost, the teacher must be a professional. He must have all the characteristics in abundance. In the areas of the emotions, ethical conduct, service and relation of confidence, much instruction is by contact and contagion. One morning the father of a youngster awoke to find the ground covered with snow. He started to the garage to get tools to clear the walk and looked back to see his young son following in his footsteps. The youngster said: "Daddy, I'm a coming". That is the way most youngsters get much of their learning; they walk in the footsteps of the father and the teacher. This following of example continues all through their lives.

No teacher who is crabid, a slave driver or unsympathetic can teach the professional attitudes of life. He must be to his students what he would like them be to their employers when they leave his classroom.

Some formal instruction is desirable. Teachers and educational administrators do not agree on the values of formal instruction. Surely anything which can be formulated may be taught, though in the items of professionalism the teacher must be careful that he does not develop a sanctimonious attitude rather than a living, full-blooded vigorous presentation. Engineers are not alone in the recognition of this problem. A half dozen years ago the lawyers made a study of "Conduct of Judges and Layers"[1] in which they took a look at instruction in the development of professional standards and ethical procedures. Some teachers said that knowing the rules of conduct does not necessarily make men moral, while others said that the schools have a duty to aid in the development of their students. The practice in teaching law, as in teaching engineering, is to run the gamut from a few lectures on professionalism to a formal course in ethics and professional practice. Again we say that the best teacher is one who practices what he teaches.

In engineering there is need for more printed material on the canons of engineering practice. Codes of ethics are available, but there is no literature of cases decided or practices recommended. In this field, the lawyers have not been afraid to go on record.

The psychologist tells us that there is little carry-over from one discipline to another, yet there must be an attitude of mind which approaches a series of problems in the same way. There are certain laws of nature which cannot be violated by a designer who wishes a safe and economical structure. Action is equal to reaction whether it be a machine, a structure or a flowing

1. Conduct of Judges and Lawyers, Phillips and McCoy.

stream. An engineer who habitually follows the laws of physics and mechanics should be habituated to follow other laws which he conceives to be right and just. Punishment for violation may not come as swiftly and as surely, but he will expect it to come. Here may be a lesson, that use of the scientific method has a tendency to condition a person for use and respect of moral and ethical laws. If there be a criticism of the point of view, it will come from the possibility of rigidity developed by closely following physical laws. Is it not the same kind of action and reaction as in mechanics when we say: "Cast thy bread upon the waters and in many days it will return unto thee," but it is action and reaction.

There are many things a teacher may do to promote a professional attitude in his students, but the most productive is the demand and expectation of excellence in their work. He should not be a slave driver or a charlatan, but a leader who does his own work well. Habitual performance of good work causes the student to accept Wickenden's doctrine of the second mile, and causes him to take sufficient care to do excellence. Slovenly work which is passable is not good enough when well done is possible.

## Industry Must Help

Much information is available regarding working conditions in industry which promote worker satisfactions and professional attitudes. First and foremost, professional workers must have intelligent and understanding supervision. The supervisor of professionals must have a two-fold objective, first to get the work done and second, to improve a worker for the organization. In the long run, the greatest asset of the company is its competent workers and their supervisory organization. Growth in stature of the professional workers adds to the assets of the company.

There is no longer a place for the "Bull of the Woods" type of supervision, rather, like a good teacher, he must be a leader and not a driver. He must know the work and be able to help beginners over the hard places.

Since professionals must develop independent thought and action, their working conditions must be suited to individual thought rather than to group activity. A working place where he can have quiet and a storage place where he can keep his papers and books are minimum essentials. As his responsibility increases, his quarters will be improved to a private office with necessary furniture and equipment and ultimately a private secretary.

An item of great personal development is writing for publication; this improves the writer and brings good notice to the employer. In addition, the profession is benefited by its members having available new ideas and new methods. The atmosphere and climate of employment should be such that engineer employees are encouraged to attend professional meetings and to contribute to their programs. Engineers today build upon the shoulders of those who have gone before, and they currently aid their fellows by broadcasting solutions of problems generated by industry of today.

If a young professional has prospects of promotion he should be made aware of his possibilities. To work toward a stone wall or up a blind alley does not give a good outlook for his best work. If he is doing well his employer should tell him, if he is doing poorly his supervisor should tell him of his faults. An optimistic and satisfied employee grows faster into professional stature than one who is dissatisfied with his work.

A great stumbling block in the way of young engineers is the threat of

unionism. Fortunately, it does not raise its head in the small organizations, but it is ever before the larger employer and his employees. A few thousand young engineers have gone into bargaining groups, but the vast majority of the more than 400,000 engineers in industry and the public service have not been convinced. Fortunately, engineering societies are outspoken in this matter, and if the climate is good in industry, the effort to organize engineers into bargaining groups will fall of its own lack of takers.

The lawyers are outspoken:[1]

> Since joining a labor union is in its infancy, it is suggested that a Canon covering the propriety of a lawyer joining a union might be adopted at the present time . . . . The approach by labor union to a question of remuneration is based on the principle that a man is entitled to be paid according to his needs, rather than according to what he produced or the value of his service. . . .
>
> Although few lawyers have joined labor unions up to this time, is it not important to take some steps to prevent what might develop into a serious detriment of the profession?

Certain engineers have made equally strong statements. To allow young engineers to seek group action for their economic betterment is to show lack of foresight by older engineers and certainly to show lack of managerial abilities in industry.

Training programs in industry offer excellent opportunities for management to give orientation on company policies, to teach special knowledge and skill essential to the industry and to give instruction and practice in professional attitudes and ideals. A person in training has not reached a fixed status and he should not be eligible to join permanent groups. During this period he should be continued in his professional concepts from college and he should graduate into a position which will ultimately lead to responsibility. With adequate knowledge of the company, with sufficient knowledge and skill to perform his job assignment and a professional atmosphere and climate, the beginning engineer should grow into a budding professional.

## Conclusion

Professionalism is a way of thinking and living rather than an accumulation of knowledge and power. Knowledge and power are exceedingly important, but professionalism has to do with their use rather than to be identified with them.

Socrates said: "If one knows what is right, he will do it." We have drifted far from this belief, yet it is the motto of the professional. His responsibilities will allow him to do no other. He is the descendent of the nobleman of the Middle Ages who accepted "noblesse o'blige" as the obligation of honorable and generous behaviour which was associated with high rank or birth. The professional must walk in the footsteps of the nobleman and torchbearer.

Lawrence Hawkins in Adventures into the Unknown has caught the idea as he writes about Willis R. Whitney, "Dean of Industrial Research:"

> To list what he accomplished would take time and space, but it would not be hard. The difficulty is to depict the man himself. For pervading, unifying, and illuminating his other qualities—his friendliness, his mental vigor, his breadth of interest and knowledge, his stimulating originality, his delightful flashes of humor,

1. Conduct of Judges and Lawyers, Phillips and McCoy.

his modesty, courage, directness and simplicity–is an indefinable charm which defies portraiture but which is felt at the instant of meeting him and which is increased and strengthened through the years of close association.

Journal of
PROFESSIONAL PRACTICE
Proceedings of the American Society of Civil Engineers

# 1959 ASCE SALARY SURVEY

Report of the Committee on Salaries of the ASCE Department of Conditions of Practice

This is the fifth in a series of ASCE biennial salary surveys. Data published here confirm the continuation of the uptrend in compensation for civil engineering services shown in the preceding surveys. Since the 1957 data were collected, professional grade* rates have increased an average of 6.2 percent—preprofessional, 2.6 percent. As in past periods, the percentage increases in the higher grades have been smaller than in the lower classifications.

In the eight-year period between 1950 and 1958** covered by the ASCE surveys, median entrance salaries for privately employed civil engineers rose 22.8 percent, while salaries of public engineering employees (ex federal) increased 40.4 percent. This disproportionate increase reflects the lower base of public salaries in 1950. The extent to which an inflated national economy influenced these rises in not determinate. Educators are not included in these studies.

By comparison, the consumers price index rose 19.9 percent between 1950 and 1958; the rise from 1956 to 1958 was 6.4 percent. Construction workers' weekly earnings climbed about 50 percent from 1950 levels, and the "Engineering News-Record" construction cost index increased about 50 percent. The United States average wage in the durable goods industries, exclusive of overtime, rose from $1.48 per hour in 1950 to $2.21 in 1958, also a 50 percent increase.

It would appear from the above that civil engineers have not been enjoying, or have failed to exploit, a runaway market for their services over the past eight years. A notable exception is the recent graduate whose median starting rate has increased over 65 percent during that period.

This report presents factual data obtained from representative sources. The data are not intended as recommended salary scales but are offered solely as an indication of current rates. It is hoped that information of this sort will help remove local inequities, and lead to fair levels of compensation in all areas of professional activity.

Note: Discussion open until February 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. Paper 2188 is part of the copyrighted Journal of Professional Practice, Proceedings of the American Society of Civil Engineers, Vol. 85, No. PP 2, September, 1959.

* See ASCE Classification of Engineering Positions—page 37.

** Salary data collected at the beginning of 1951 and 1959 actually reflect 1950 and 1958 rates.

## Bases of Survey

Questionnaires similar to those used for the 1957 survey were mailed in January 1959. As in previous years, the survey was conducted on a sampling basis. In 1959, returns were received from 331 organizations representing 64,080 employees. Comparable figures for 1957 were 297 and 47,716 respectively. Distribution of respondents to the 1959 survey by category is as follows:

| | No. of Organizations | | No. of Engineering Employees | |
|---|---|---|---|---|
| Consulting Firms | 90 | | 6,401 | |
| Construction Firms | 30 | | 2,561 | |
| Railroads, Utilities & Industries | 30 | | 4,630 | |
| Total private organizations | | 150 | | 13,592 |
| State Highway Departments | 36 | | 42,393 | |
| Municipalities & Counties | 54 | | 6,422 | |
| Total public agencies | | 90 | | 48,815 |
| Educational Institutions | 91 | 91 | 1,673 | 1,673 |
| Grand Total | | 331 | | 64,080 |

NOTE: No replies were solicited from federal agencies for purposes of this report, since, with few exceptions, the U. S. Civil Service Commission salary rates are standard throughout the country (see Table IX and Fig. 10).

## Presentation of Data

Although respondents to the 1959 survey do not entirely duplicate those represented in the 1957 survey, the overlap is sufficient to warrant comparison. Salaries are reported according to entrance and maximum rates for all twelve ASCE grades in each category surveyed (Tables II through VII). Rates are given for the median, middle 50 percent, and total range in each grade. Table VIII presents a comparison of salary rates for combined grades in each category. No attempt is made here to weight medians according to the number of employees represented by each salary rate reported.

The median is that figure having 50 percent of the replies lower and 50 percent higher. The middle 50 percent is determined by eliminating the upper 25 percent and lower 25 percent. Total range represents the lowest and highest figures reported in each grade.

Many of the respondents to this survey do not have grade classification systems paralleling the ASCE grade series. It is probable therefore that widely divergent figures reported in the total range are the result of misinterpretation of definition rather than marked disparity in salary scales. However, the range represented by the middle 50 percent may be assumed to reflect a reasonably accurate relationship of salary rates.

## Graphical Presentation

Charts accompanying the tables for each category (Figs. 4 through 9) present graphical studies of salary trends. The curve near the top of each chart shows the pattern of changes in entrance rate medians for each grade. Lack of consistency in the shapes of these curves indicates that rate changes vary in comparable grade levels for each category. This is true of preprofessional as well as professional classifications.

Curves for entrance and maximum medians in all grades of each category appear in the lower section of each chart. Values for the 1957 entrance medians are plotted for comparative purposes. It will be noted that the 1959 median curves drop below the 1957 values at some grade levels for consulting firms, construction firms, and municipalities and counties (Figs. 4, 5 and 7), probably because of normal "scatter" in the 1957 and 1959 data. A significant drop of 8.8 percent is seen in the preprofessional rates for contractors. A 1.0 percent drop in the combined professional grades for municipalities and counties may have little significance since the sampling for this category was quite light in 1957.

The greatest increase in combined preprofessional rates is 14.1 percent for railroads, utilities and industries (Fig. 8). Greatest increase in combined professional grades is 11.1 percent for educators (Fig. 9).

## Comparative Changes by Category

The following tabulation shows overall percentage changes (1957-1959) in preprofessional and professional classifications for each category surveyed. These figures are based on averages of entrance medians for combined grades in each category:

| | Preprofessional | Professional |
|---|---|---|
| Consulting Firms | +2.2 | +6.9 |
| Construction Firms | -8.8 | +10.2 |
| State Highway Departments | +4.6 | +8.3 |
| Municipalities & Counties | +2.2 | -1.0 |
| Railroads, Utilities & Industries | +14.1 | +4.3 |
| Educational Institutions | ---- | +11.1 |
| All categories combined | +2.6 | +6.2 |

Note: Increases in federal salary rates (Table IX) range from 10 to 22 percent. The greatest increase is in the entrance rate for Federal Grade GS-5 (ASCE Grade I). The overall increase (all grades combined) is 13 percent. The latter figure is comparable to a 5.7 percent increase for combined entrance grades (professional and preprofessional) for all categories surveyed.

## Educational Institutions

Pay increases for educators range from 6 percent for instructors to 14 percent for professors. Rates for assistant and associate professors show

an 11 percent increase—heads of departments, 12 percent. For comparative purposes, salaries paid by educational institutions are adjusted to an eleven-month basis in Table VII and Fig. 9. A similar adjustment was made in the 1957 report. Tables VIII and XXIII present salary data for educators on both actual and adjusted bases. No attempt is made here to evaluate educator's supplementary income.

## Starting Salaries for College Graduates

National entrance rates to Grade I, 1951 through 1959, are shown in Fig. 3. An increase of $225 per year for the 1957-59 survey period is within reasonable range of the $266 yearly average for the three preceding biennial surveys.

The 1957-1959 increase in Grade I is 10 percent. Comparable increases for 1955-1957 and 1953-1955 were 18 and 8 percent, respectively.

The average increase in the 1959 survey for professional grades II through IX is 5.9 percent. The range here is from 3 percent for Grades VII and IX to 9 percent for Grade VIII. (See Fig. 2.) Proportionately greater increases in compensation for Grade I reflect the continued demand for engineers just out of college. The comparable federal grade (GS-5) increased 22 percent in the same period. (See Table IX.)

## Regional Relationships

A regional breakdown for each grade of each category surveyed is given in Tables X through XXII. Table XXIII gives a regional comparison of the median rates of all grades combined for each category.

Table I establishes regional relationships for combined grades in each category.* This table excludes educational institutions because of differences in grade classifications.

The accompanying map (Fig. 1) shows the geographical makeup of the six regions indentified as:

I New England
II Middle Atlantic
III Middle West
IV South
V West
VI Far West

## Fringe Benefits

Tangible benefits are gaining greater acceptance with organizations employing large numbers of engineers. These "plus" factors, commonly termed

*These ratios are not to be confused with the salary index figures published monthly in Civil Engineering. The ASCE Engineering Salary Index shows nation-wide trends. Adjustments are made semiannually to bridge the period between biennial surveys. The ESI is computed by dividing the current salary total for ASCE Grades I, II and III by an arbitrary base, $15,930. This figure is the total of salaries paid in 1956 for the equivalent Federal Grades GS-5, GS-7 and GS-9. Only the annual base entrance salaries are used in these calculations.

fringe benefits, or perquisites, are subject to specific dollar evaluation. Added to the payroll rate, they produce a sum that may be designated "total equivalent compensation."

For the purpose of this report, no attempt is made to determine total equivalent compensation. However, respondents to the 1959 ASCE Survey have provided ample data to warrant a separate study. An analysis of such tangibles as bonuses, profit-sharing plans, annual leave, sick leave, retirement, health and life insurance programs will shed light on the importance fringe benefits have assumed in the overall pay structure of many organizations.

## ACKNOWLEDGMENT

The ASCE biennial salary surveys have been conducted in conformance with Society Bylaws that commission the Committee on Salaries to ". . . collect, codify and prepare for distribution such data as may be calculated to be of value to employers of civil engineers and to civil engineering employees in connection with the proper classification of engineering positions and equitable compensation for such services." Effective August 1, 1959, a change in the Bylaws combines the work of the Committee on Salaries with that of the Committee on Employment Conditions. Present plans call for continuation of the biennial salary surveys by the latter committee.

The Committee on Salaries is grateful to all those who supplied the basic data that made this report possible. Heavy demand for copies of past surveys is indicative of the value of periodical appraisals of civil engineering salaries. The Committee also wishes to express its appreciation for the contributions made to the collection of data and the preparation of this report by the headquarters staff.

Respectfully submitted,
ASCE Committee on Salaries

Oscar S. Bray, Chairman
William J. Carroll, Jr., Vice Chairman
Warren W. Parks
Melvin R. Williams
Randle B. Alexander

## ASCE Classification of Civil Engineering Positions

Compilation of salary survey data by grade provides a practical means for determining current rates and analyzing trends. As in previous reports, the ASCE classification series is used here—three preprofessional and nine professional grades. Requirements for each grade are specified in terms of employee duties and responsibilities. These and other basic criteria determine the relative levels of engineering positions.

There is likely to be some overlapping in the various grades. This is particularly true of Grade C (preprofessional) and Grade I (professional). Employees at the top of the Grade C classification may have graduated from college. Or they may possess the equivalent of a college degree in education and experience. These men are in preprofessional work with the full

expectation of advancing to the professional level. The term "preprofessional" is to be distinguished from that of "subprofessional." The latter is applied to employees who do not qualify for advancement through the professional grades.

Specifications for the nine ASCE professional grades were adopted in 1946. They are based, grade for grade, on the requirements for the U. S. Civil Service Commission professional grade series, P-1 through P-9. Since October, 1949, these federal grades have been identified as GS-5, 7, 9, 11, 12, 13, 14, 15 and 16, respectively. The requirements have not changed. The equivalent "GS" grade is given in the following ASCE professional grade descriptions.

The professional classifications include all positions that call for operational, creative, advisory, administrative, or research work based on established principles of the civil engineering profession. The fundamental prerequisite for all professional grades is a first degree in engineering from a college or university of recognized standing, or the equivalent in professional, scientific or technical training.

The following descriptive classifications for preprofessional and professional grades are those used in the form submitted with the questionnaire for the 1959 ASCE Salary Survey.

## Preprofessional Grades

Grade A positions are to include employees who are able, under supervision, with little or no previous experience, to assist with simple routine engineering work in field or office.

Typical tasks are to serve in the field as chainman or flagman, in the office to index and file plans and survey books, to copy engineering data, to make simple arithmetical calculations, or to check and plot level notes.

Grade B positions are to include employees who are able, under supervision, to do the simpler types of preprofessional engineering work in office, laboratory and field, not necessarily requiring professional engineering training but requiring some experience.

Typical tasks are to serve as rodman on survey or construction work, to make simple survey or construction notes, to do simple level and transit work, to perform simple routine testing, or to do simple engineering office work including arithmetical calculations.

Grade C positions are to include employees who are able, under supervision, to do engineering work somewhat more difficult than that required in Grade B, in office, laboratory, or field, not necessarily requiring professional engineering training, but requiring qualifying experience.

Typical tasks are to make graphs and charts, to perform ordinary engineering computations, to make and check survey and construction notes, to make routine construction drawings, to do level and transit work, to make routine inspections on construction work, or to make routine tests of the properties of soils or materials of construction.

## Professional Grades

Grade I includes all positions which involve, under immediate supervision, the performance of fundamental civil engineering duties requiring professional training but little or no experience. (Federal GS-5)

Grade II includes all positions which involve, under immediate or general supervision, individually or with a small number of subordinates, the performance of civil engineering duties requiring professional training, previous experience, and to a limited extent the exercise of independent judgment. (Federal GS-7)

Grade III includes all positions which involve, under general supervision, individually or with a number of subordinates, the performance of civil engineering duties of substantial difficulty and responsibility requiring professional training, previous experience, and independent judgment. (Federal GS-9)

Grade IV includes all positions which involve, under general supervision, individually or with a number of subordinates, the performance of difficult civil engineering duties, or the supervision of a subdivision of an engineering organization, requiring professional training, previous experience, recognized leadership, and independent judgment. (Federal GS-11)

Grade V includes all positions which involve, under general supervision, individually or with a number of subordinates, the performance of difficult civil engineering duties, or the supervision of a division of an engineering organization, or the direction of a staff on investigative studies, research and testing, design, or construction, requiring professional training, previous experience, recognized leadership and independent judgment. (Federal GS-12)

Grade VI includes all positions which involve, under general direction, individually or with a number of subordinates, the performance of difficult civil engineering duties or the supervision of a division of an engineering organization, or acting as the principal assistant to the head of a division of a large engineering organization, or the direction of a staff on investigative studies, design or construction, requiring professional training, successful experience in engineering work. (Federal GS-13)

Grade VII includes all positions which involve, under general direction, individually or with a number of subordinates, the performance of important civil engineering duties or the supervision of a division of a large engineering organization, or the direction of a staff on investigative studies, design or construction, requiring professional training, extensive successful experience in engineering work with demonstrated aptitude and capacity for increased responsibilities in managerial and executive functions. (Federal GS-14)

Grade VIII includes all positions, such as:

a) the assistant to the technical and administrative head of an important engineering organization; or

b) the technical and administrative head of a lesser engineering organization; or

c) positions involving the development, analysis, and evaluation, for final executive action, of difficult and complex engineering projects with respect to their feasibility, cost, economic justification, and public necessity or convenience. (Federal GS-15)

Grade IX includes all positions, such as:

a) the administrative and professional head of an important engineering organization with full authority and responsibility for conceiving and executing all the plans and functions of the organization, directing an administrative and professional engineering staff engaged in varied important projects; or

b) positions requiring highly specialized professional engineering or scientific ability. (Federal GS-16)

The duties of faculty members in educational institutions are not such as to

fit into the foregoing classifications. Therefore, as will be noted in Table VII and Fig. 9, returns were requested on the basis of salaries for Instructor, Assistant Professor, Associate Professor, Professor, and Head of Department.

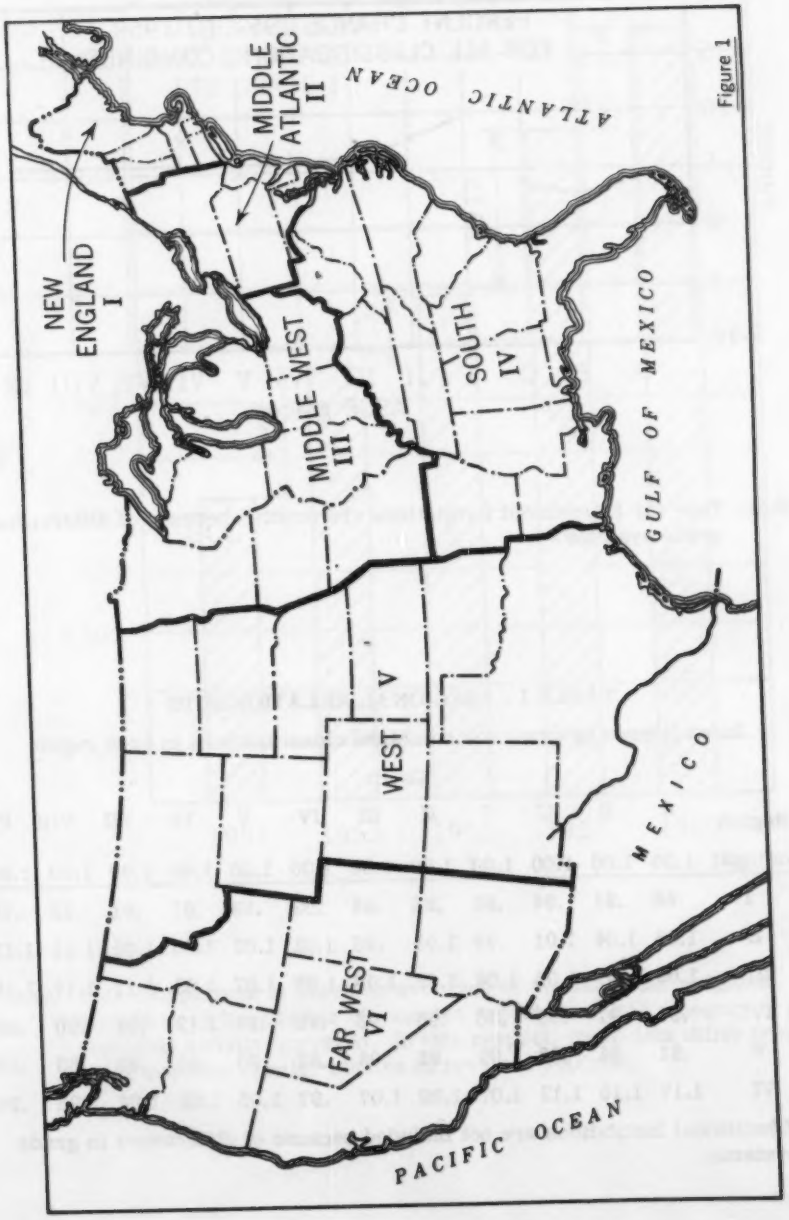
NEW ENGLAND I
MIDDLE ATLANTIC II
ATLANTIC OCEAN
MIDDLE WEST III
SOUTH IV
GULF OF MEXICO
WEST V
MEXICO
FAR WEST VI
PACIFIC OCEAN

Figure 1

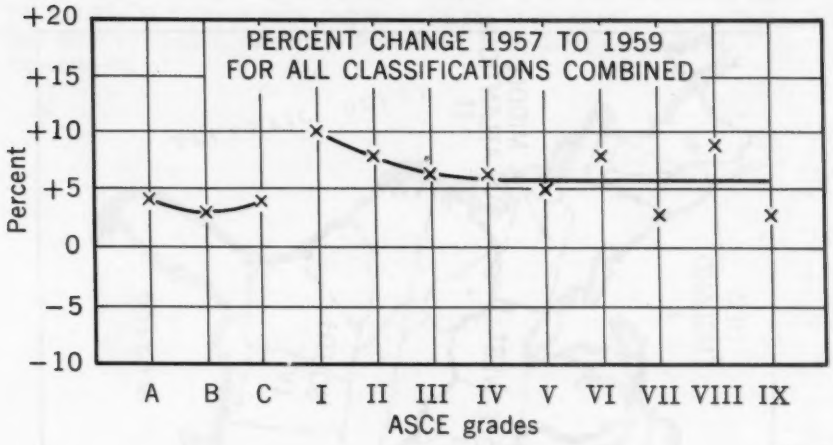


Fig. 2

Note: Data for Educational Institutions are omitted because of differences in grade systems.

TABLE I - *REGIONAL RELATIONSHIPS

Index figures by grade for combined classifications in each region

| Region | Grade A | B | C | I | II | III | IV | V | VI | VII | VIII | IX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| I | .88 | .91 | .84 | .86 | .85 | .88 | .92 | .92 | .87 | .81 | .79 | .73 |
| II | 1.05 | 1.04 | 1.01 | .99 | 1.03 | .96 | 1.02 | 1.02 | 1.00 | 1.05 | 1.11 | 1.13 |
| III | 1.08 | 1.07 | 1.05 | 1.04 | 1.08 | 1.09 | 1.09 | 1.07 | 1.02 | 1.17 | 1.14 | 1.19 |
| IV | .91 | .91 | .99 | .96 | .98 | .96 | .95 | .97 | 1.12 | .93 | .90 | .95 |
| V | .81 | .84 | .88 | .99 | .96 | .93 | .89 | .90 | .85 | .90 | .88 | .89 |
| VI | 1.17 | 1.15 | 1.12 | 1.07 | 1.09 | 1.07 | .97 | 1.06 | 1.02 | 1.04 | .95 | .96 |

*Educational Institutions are not included because of differences in grade systems.

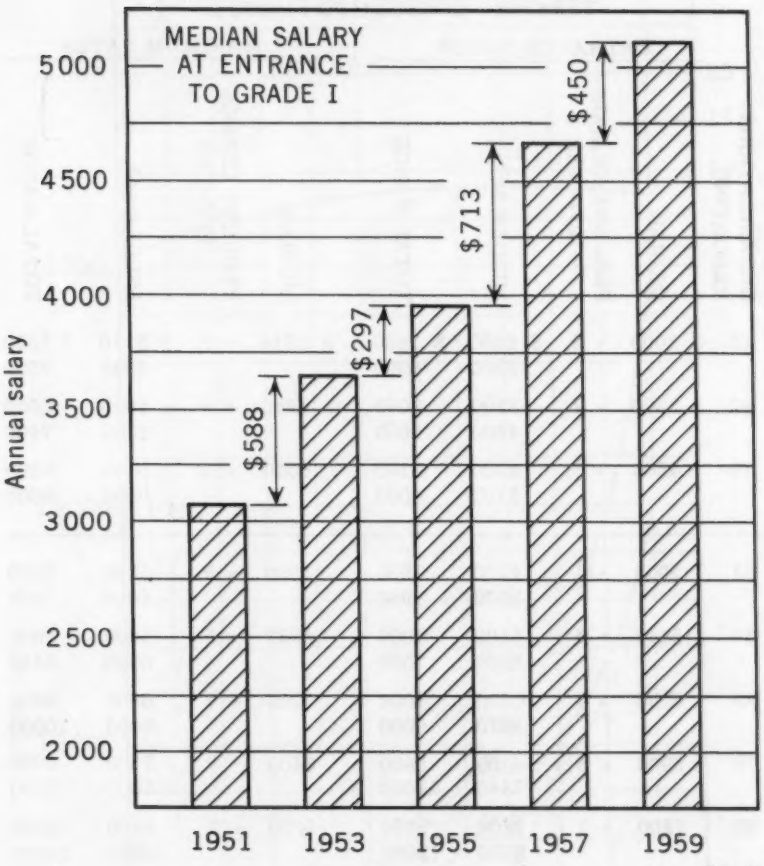


Fig. 3

Note: This comparison is based on averages of median rates weighted according to the number of samples reported in each category of professional activity surveyed. In this respect, these data differ from those used for similar studies in previous reports.

TABLE II - CONSULTING FIRMS

| ASCE GRADE | ORGANIZATIONS REPORTING | ENTRANCE RATES | | | | MAXIMUM RATES | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE |
| A | 62 | $ 3000 | + 3 | $ 2600<br>3300 | $ 1680<br>6000 | $ 3814 | - 1 | $ 3370<br>4350 | $ 2080<br>7000 |
| B | 69 | 3600 | - 2 | 3300<br>4200 | 2080<br>6600 | 4680 | + 4 | 4000<br>5200 | 2600<br>7400 |
| C | 79 | 4500 | + 5 | 4000<br>5100 | 3120<br>8000 | 6000 | +10 | 5400<br>6600 | 3600<br>9600 |
| I | 73 | 5000 | +11 | 4200<br>5400 | 2600<br>6900 | 5900 | + 9 | 5200<br>6000 | 3200<br>7280 |
| II | 76 | 5430 | + 6 | 5100<br>6000 | 3000<br>7500 | 6322 | + 5 | 6000<br>6900 | 4000<br>8850 |
| III | 83 | 6100 | + 3 | 5700<br>6630 | 4000<br>9000 | 7200 | + 7 | 6600<br>8000 | 5000<br>10000 |
| IV | 78 | 6900 | + 6 | 6300<br>7440 | 5000<br>11000 | 8400 | + 9 | 7500<br>9000 | 6000<br>12000 |
| V | 80 | 7800 | + 7 | 7200<br>8580 | 5400<br>12000 | 9000 | + 3 | 8400<br>10400 | 6300<br>14000 |
| VI | 66 | 9000 | + 9 | 8320<br>9620 | 6000<br>14000 | 10652 | + 7 | 9300<br>12000 | 6900<br>17000 |
| VII | 60 | 10000 | + 6 | 9000<br>10800 | 6240<br>14652 | 12000 | + 8 | 10200<br>14000 | 7200<br>20000 |
| VIII | 54 | 11700 | +11 | 9940<br>14000 | 7200<br>20000 | 15000 | +10 | 12000<br>19440 | 7500<br>30000 |
| IX | 42 | 15000 | + 4 | 12000<br>37712 | 8000<br>50000 | 19968 | + 1 | 15000<br>25000 | 10200<br>60000 |

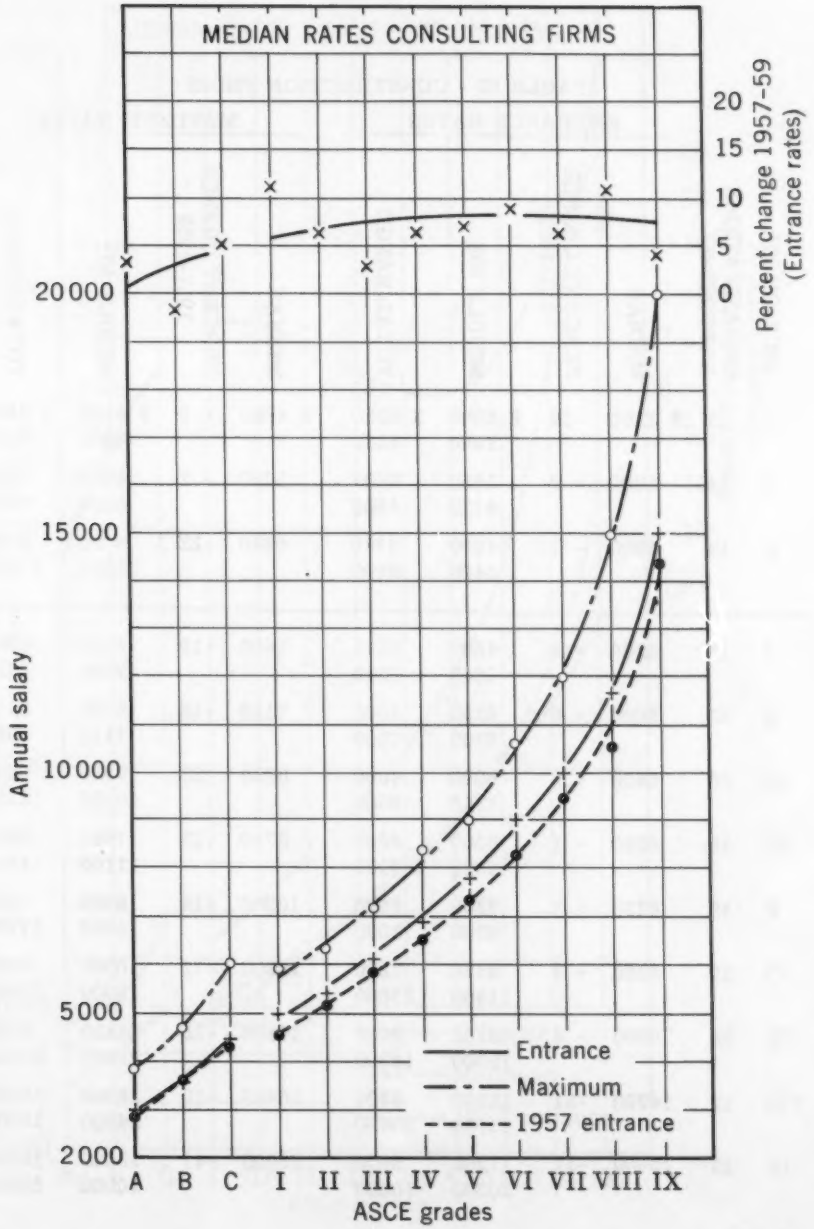
MEDIAN RATES CONSULTING FIRMS
Annual salary
20000
15000
10000
5000
2000
Percent change 1957-59
(Entrance rates)
20
15
10
5
0
Entrance
Maximum
1957 entrance
A B C I II III IV V VI VII VIII IX
ASCE grades

Fig. 4

TABLE III - CONSTRUCTION FIRMS

| ASCE GRADE | ORGANIZATIONS REPORTING | ENTRANCE RATES | | | | MAXIMUM RATES | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE |
| A | 13 | $ 3300 | -19 | $ 3000<br>3900 | $ 2080<br>4888 | $ 4680 | - 5 | $ 4000<br>4800 | $ 2600<br>7100 |
| B | 14 | 4000 | - 7 | 3550<br>4122 | 2600<br>4500 | 5050 | - 2 | 4720<br>5500 | 3120<br>6300 |
| C | 14 | 4800 | - 1 | 4500<br>5400 | 3120<br>6300 | 6680 | +13 | 6000<br>7500 | 5000<br>11600 |
| I | 16 | 5200 | +12 | 4800<br>5500 | 4420<br>6240 | 6400 | +19 | 6000<br>7200 | 4940<br>8528 |
| II | 22 | 5600 | + 8 | 5250<br>6300 | 4000<br>7800 | 7110 | +16 | 6500<br>7410 | 5200<br>9960 |
| III | 20 | 6400 | + 6 | 6000<br>7320 | 4800<br>9000 | 8680 | +23 | 7500<br>10192 | 6200<br>12300 |
| IV | 18 | 6950 | - 1 | 6500<br>8325 | 4800<br>9984 | 8710 | +13 | 7885<br>11100 | 6400<br>14400 |
| V | 18 | 8230 | + 3 | 7350<br>9500 | 6600<br>12000 | 10800 | +14 | 9000<br>14400 | 7200<br>17700 |
| VI | 19 | 9290 | + 8 | 8320<br>11400 | 7200<br>25000 | 12000 | +12 | 10000<br>15000 | 9000<br>20000 |
| VII | 20 | 9800 | - 4 | 9100<br>12000 | 7000<br>18200 | 14100 | +25 | 12480<br>18000 | 9600<br>25000 |
| VIII | 12 | 14700 | +31 | 12000<br>15000 | 8400<br>20400 | 18880 | +18 | 18000<br>24000 | 12000<br>30000 |
| IX | 13 | 15600 | +17 | 13200<br>20000 | 9600<br>30000 | 25000 | +41 | 18000<br>30000 | 18000<br>50000 |

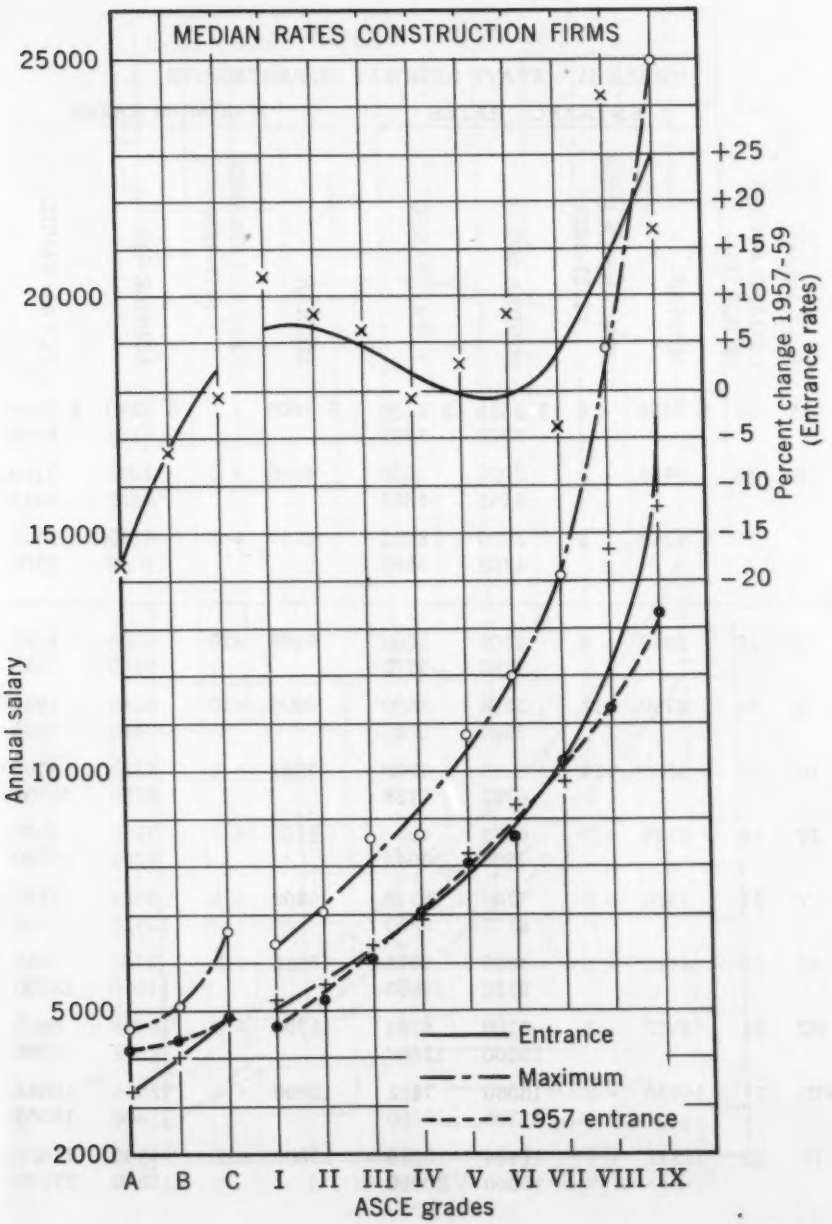
MEDIAN RATES CONSTRUCTION FIRMS
25000
20000
15000
10000
5000
2000
Annual salary
+25
+20
+15
+10
+5
0
−5
−10
−15
−20
Percent change 1957-59
(Entrance rates)
Entrance
Maximum
1957 entrance
A B C I II III IV V VI VII VIII IX
ASCE grades

Fig. 5

TABLE IV - STATE HIGHWAY DEPARTMENTS

| ASCE GRADE | ORGANIZATIONS REPORTING | ENTRANCE RATES | | | | MAXIMUM RATES | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE |
| A | 33 | $ 2880 | + 6 | $ 2525<br>3300 | $ 2100<br>3792 | $ 3600 | + 5 | $ 3240<br>4104 | $ 2700<br>4900 |
| B | 35 | 3456 | + 3 | 3024<br>3792 | 2400<br>4512 | 4295 | + 3 | 4032<br>4620 | 3180<br>6144 |
| C | 33 | 4147 | + 5 | 3900<br>4368 | 2820<br>5496 | 5256 | + 5 | 4940<br>6000 | 3480<br>7200 |
| I | 36 | 5040 | + 9 | 4704<br>5220 | 3060<br>5772 | 6108 | +10 | 5580<br>6360 | 4080<br>7332 |
| II | 33 | 5760 | +12 | 5268<br>5992 | 3600<br>6600 | 6900 | +10 | 6540<br>7440 | 4860<br>9900 |
| III | 33 | 6564 | +14 | 5820<br>6732 | 4200<br>7728 | 7764 | + 9 | 7228<br>8220 | 5300<br>10600 |
| IV | 34 | 7174 | +13 | 6420<br>7500 | 4920<br>8940 | 8460 | + 7 | 7920<br>9144 | 6474<br>11300 |
| V | 31 | 7920 | + 8 | 7200<br>8372 | 5590<br>9300 | 9300 | + 5 | 8784<br>10320 | 7124<br>12000 |
| VI | 33 | 8712 | + 6 | 7896<br>9120 | 5876<br>10860 | 10416 | + 3 | 9768<br>11540 | 7488<br>13200 |
| VII | 32 | 9702 | + 3 | 8700<br>10200 | 6786<br>12600 | 11790 | + 8 | 10956<br>12632 | 8658<br>15600 |
| VIII | 31 | 10800 | + 8 | 10080<br>11700 | 7852<br>13800 | 12600 | + 4 | 12084<br>13800 | 10036<br>18000 |
| IX | 32 | 12318 | + 7 | 11664<br>14000 | 10036<br>20000 | 15000 | +12 | 14200<br>16800 | 11622<br>22800 |

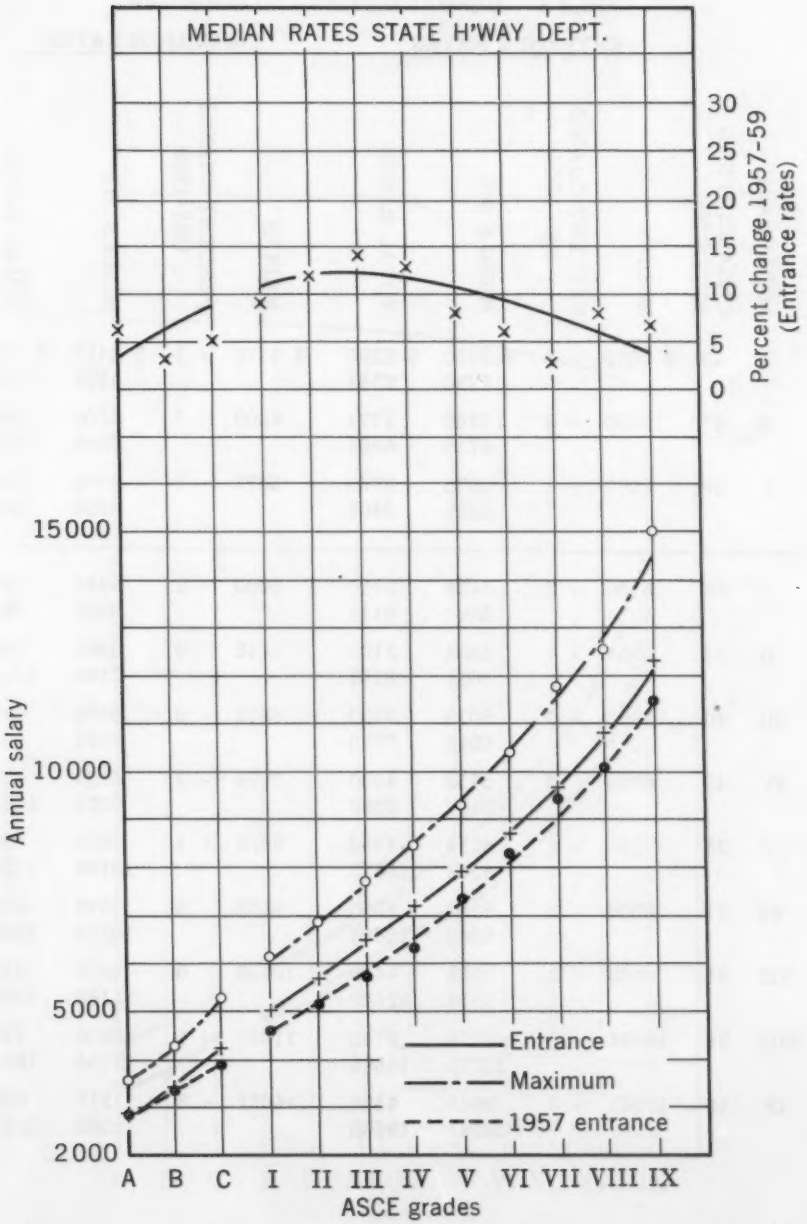
MEDIAN RATES STATE H'WAY DEP'T.
30
25
20
15
10
5
0
Percent change 1957-59
(Entrance rates)
15000
10000
5000
2000
Annual salary
Entrance
Maximum
1957 entrance
A B C I II III IV V VI VII VIII IX
ASCE grades

Fig. 6

TABLE V - MUNICIPALITIES AND COUNTIES

| ASCE GRADE | ORGANIZATIONS REPORTING | ENTRANCE RATES | | | | MAXIMUM RATES | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE |
| A | 49 | $ 3276 | - 3 | $ 2760<br>3780 | $ 2280<br>6348 | $ 4170 | + 3 | $ 3420<br>4904 | $ 2916<br>7728 |
| B | 47 | 4050 | + 8 | 3360<br>4716 | 2772<br>6664 | 4909 | + 8 | 4500<br>5574 | 3456<br>8736 |
| C | 49 | 4386 | + 2 | 3876<br>5098 | 2760<br>6408 | 5377 | + 5 | 4776<br>5959 | 3360<br>8640 |
| I | 38 | 5100 | + 2 | 4428<br>5580 | 2750<br>8112 | 6000 | + 3 | 5340<br>6552 | 3150<br>9876 |
| II | 41 | 5554 | + 7 | 4608<br>6024 | 3100<br>9168 | 6448 | 0 | 5640<br>7100 | 3600<br>11172 |
| III | 40 | 5940 | - 3 | 5018<br>6848 | 3700<br>7770 | 6875 | - 9 | 5376<br>7884 | 4200<br>9528 |
| IV | 43 | 6739 | 0 | 5455<br>7487 | 4000<br>9390 | 7674 | - 6 | 6702<br>9026 | 4700<br>10880 |
| V | 38 | 7284 | + 4 | 6235<br>8562 | 4350<br>10332 | 8610 | - 1 | 7806<br>10164 | 5800<br>11592 |
| VI | 37 | 8008 | - 2 | 6360<br>9060 | 4560<br>10663 | 9456 | - 5 | 7874<br>10256 | 5160<br>12870 |
| VII | 35 | 9000 | + 2 | 7386<br>9954 | 4450<br>12600 | 10440 | 0 | 9000<br>11199 | 6150<br>15000 |
| VIII | 36 | 10384 | - 2 | 8276<br>11395 | 6750<br>14644 | 11993 | + 1 | 10608<br>13004 | 7519<br>18480 |
| IX | 40 | 12583 | - 9 | 9985<br>14545 | 4550<br>19500 | 14621 | + 2 | 11317<br>16568 | 6900<br>22956 |

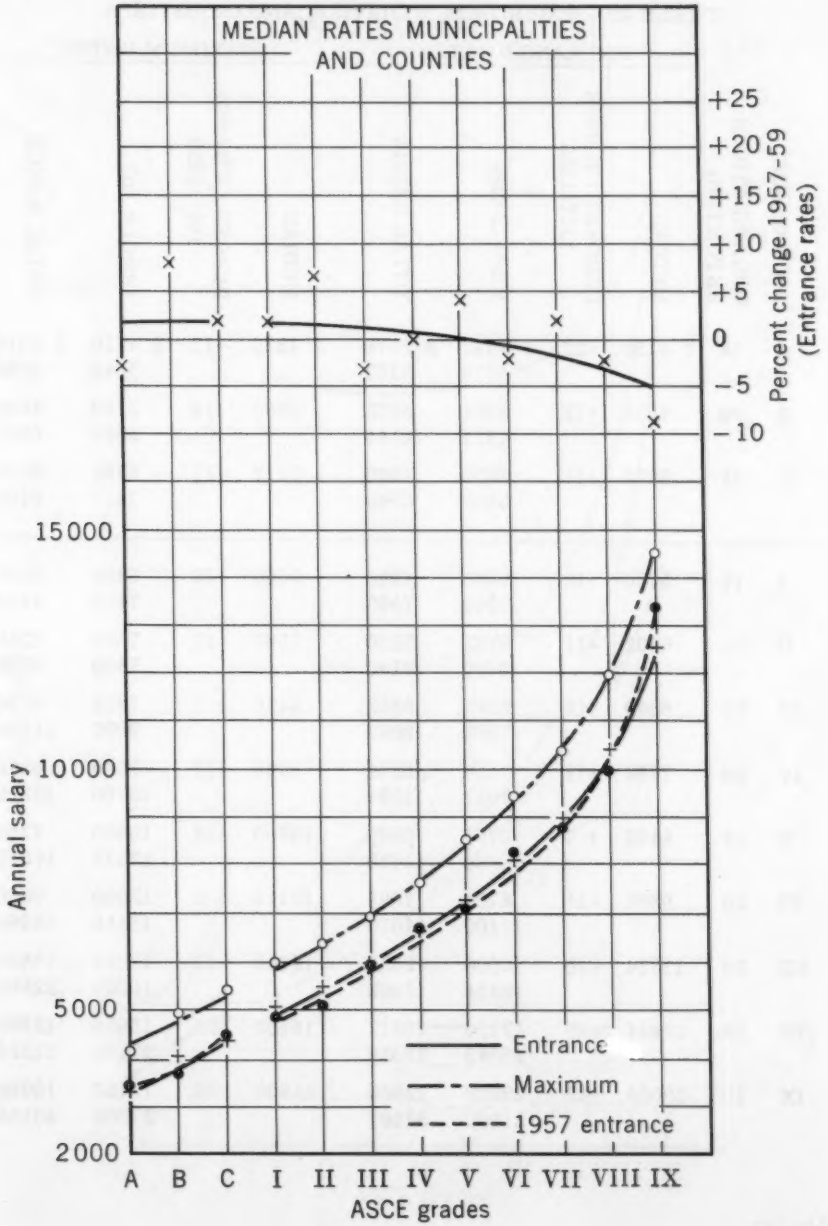
MEDIAN RATES MUNICIPALITIES AND COUNTIES
+25
+20
+15
+10
+5
0
−5
−10
Percent change 1957-59 (Entrance rates)
15000
10000
5000
2000
Annual salary
Entrance
Maximum
1957 entrance
A B C I II III IV V VI VII VIII IX
ASCE grades

Fig. 7

TABLE VI - RAILROADS, UTILITIES, AND INDUSTRIES

| ASCE GRADE | ORGANIZATIONS REPORTING | ENTRANCE RATES | | | | MAXIMUM RATES | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE |
| A | 18 | $ 4150 | +22 | $ 3443<br>4379 | $ 2676<br>5263 | $ 4830 | +15 | $ 4710<br>5046 | $ 3516<br>5760 |
| B | 20 | 4638 | +11 | 3934<br>4971 | 3072<br>6144 | 5586 | +14 | 5160<br>5889 | 4200<br>6924 |
| C | 21 | 5200 | +11 | 4824<br>5460 | 3840<br>6040 | 7227 | +27 | 6793<br>7410 | 6600<br>8196 |
| I | 17 | 5760 | +12 | 5400<br>5940 | 4980<br>7590 | 7050 | +18 | 6300<br>7410 | 5760<br>8130 |
| II | 24 | 6102 | +11 | 5772<br>6480 | 5200<br>8130 | 7597 | +12 | 7000<br>7800 | 6240<br>8820 |
| III | 27 | 6840 | +12 | 6360<br>7068 | 5642<br>9090 | 8436 | + 7 | 7920<br>9000 | 6360<br>11800 |
| IV | 26 | 7762 | +11 | 7128<br>7937 | 6264<br>11580 | 9788 | +11 | 8940<br>10760 | 6840<br>13200 |
| V | 24 | 8490 | + 7 | 7764<br>9000 | 6960<br>12420 | 10800 | +13 | 10080<br>12237 | 7260<br>14670 |
| VI | 20 | 9888 | +14 | 8700<br>11100 | 7896<br>14670 | 12216 | + 9 | 12000<br>15146 | 9000<br>18994 |
| VII | 20 | 11324 | +10 | 10000<br>12324 | 8636<br>18589 | 14048 | +12 | 12828<br>15600 | 10500<br>22999 |
| VIII | 13 | 13944 | +19 | 12120<br>15089 | 10512<br>30630 | 16500 | +22 | 15936<br>20400 | 13680<br>32224 |
| IX | 11 | 20000 | +42 | 18000<br>21000 | 12960<br>34567 | 24500 | +36 | 19450<br>27800 | 15060<br>40148 |

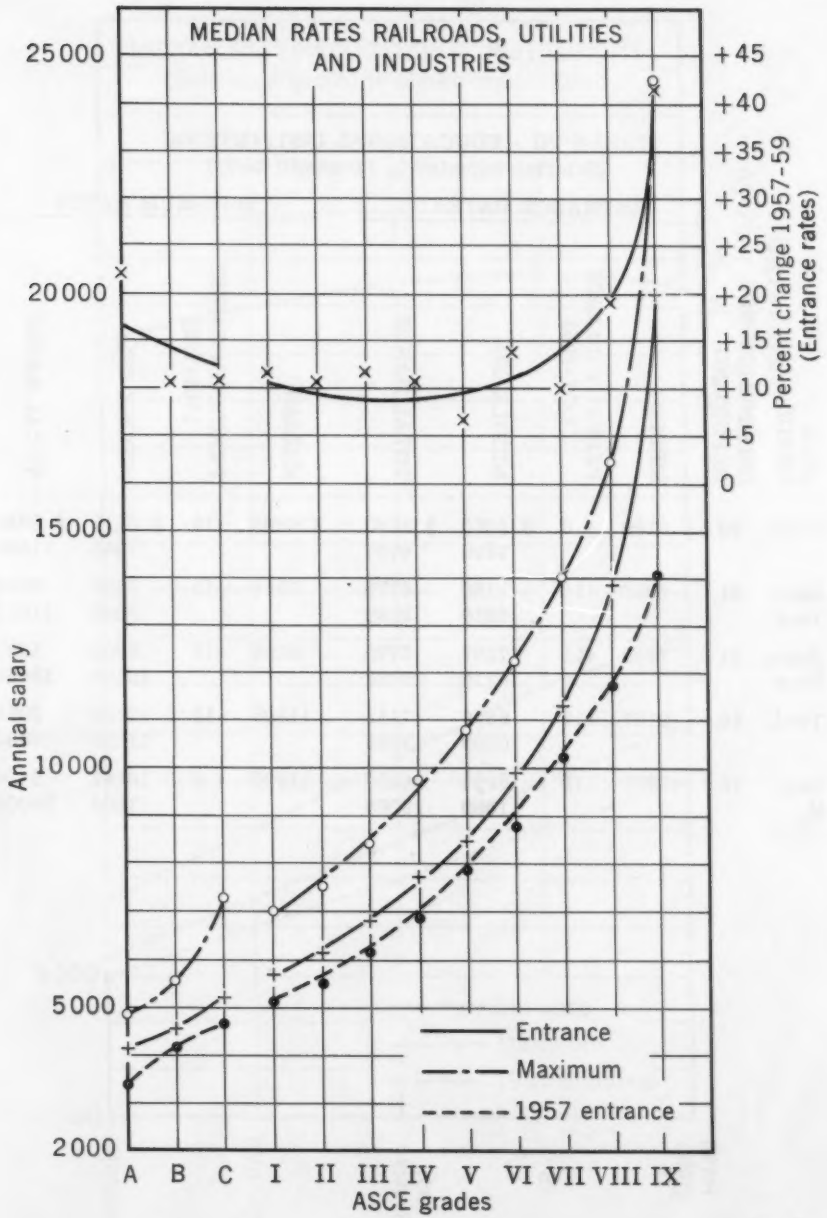
MEDIAN RATES RAILROADS, UTILITIES AND INDUSTRIES
25000
20000
15000
10000
5000
2000
Annual salary
+45
+40
+35
+30
+25
+20
+15
+10
+5
0
Percent change 1957-59 (Entrance rates)
Entrance
Maximum
1957 entrance
A B C I II III IV V VI VII VIII IX
ASCE grades

Fig. 8

## TABLE VII - EDUCATIONAL INSTITUTIONS
(Salaries adjusted to 11-month basis)

| ASCE GRADE | ORGANIZATIONS REPORTING | ENTRANCE RATES | | | | MAXIMUM RATES | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE | MEDIAN | PERCENT CHANGE 1957-1959 | MIDDLE 50% | TOTAL RANGE |
| Instr. | 90 | $ 5280 | + 6 | $ 5060<br>5866 | $ 3960<br>6856 | $ 6600 | +14 | $ 6111<br>7049 | $ 5060<br>11488 |
| Asst. Prof. | 91 | 6600 | +11 | 6160<br>6930 | 5279<br>8280 | 7944 | +13 | 7529<br>8556 | 6230<br>11611 |
| Assoc. Prof. | 91 | 7700 | +11 | 7207<br>8310 | 5770<br>9778 | 9228 | +13 | 8600<br>10300 | 4557<br>13440 |
| Prof. | 86 | 9167 | +14 | 8556<br>10200 | 7112<br>13444 | 11300 | +12 | 10389<br>13020 | 8085<br>19800 |
| Dept. H. | 76 | 10053 | +12 | 8957<br>11000 | 6435<br>19000 | 11800 | + 9 | 10144<br>13500 | 9130<br>24000 |

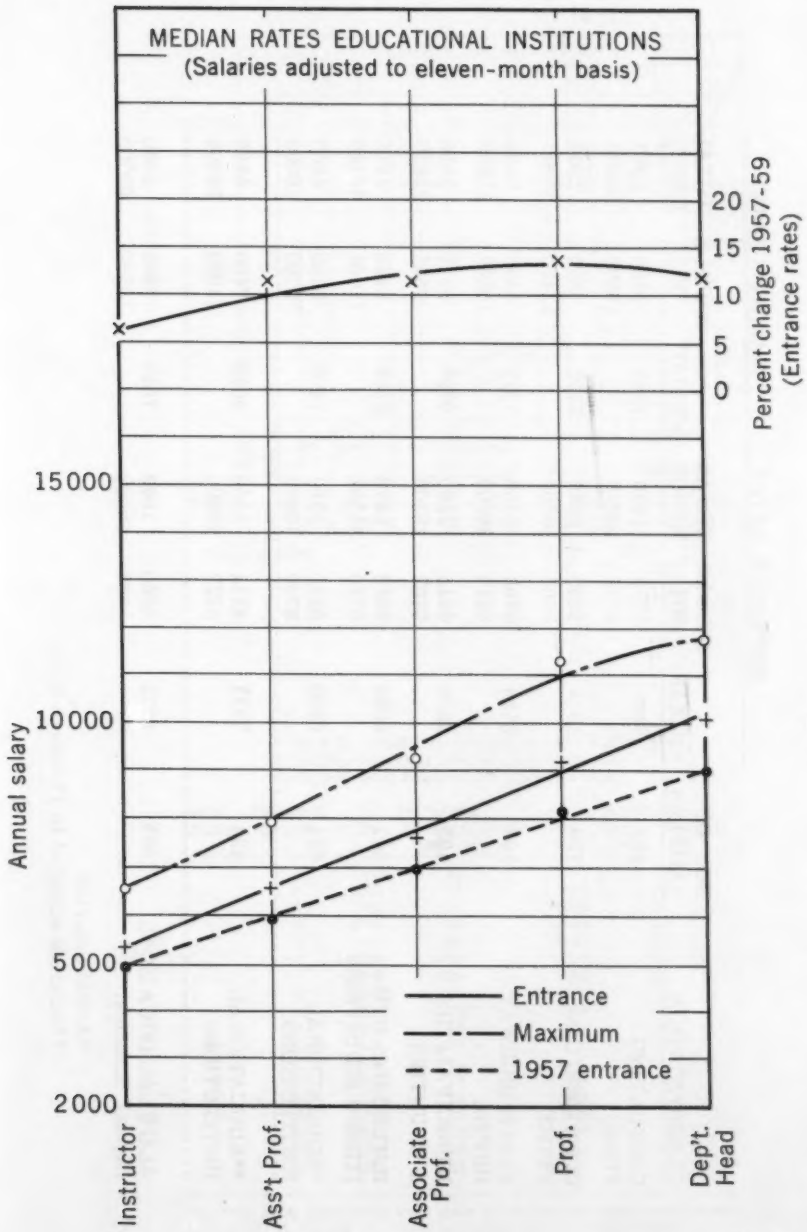
MEDIAN RATES EDUCATIONAL INSTITUTIONS
(Salaries adjusted to eleven-month basis)
Annual salary
15000
10000
5000
2000
20
15
10
5
0
Percent change 1957-59
(Entrance rates)
Entrance
Maximum
1957 entrance
Instructor
Ass't Prof.
Associate Prof.
Prof.
Dep't. Head

Fig. 9

TABLE VIII - COMPARISON OF COMBINED GRADES IN EACH CLASSIFICATION

| CLASSIFICATION | NO. OF SAMPLES | ENTRANCE RATES MEDIAN | ENTRANCE RATES MIDDLE 50% | ENTRANCE RATES TOTAL RANGE | MAXIMUM RATES MEDIAN | MAXIMUM RATES MIDDLE 50% | MAXIMUM RATES TOTAL RANGE |
|---|---|---|---|---|---|---|---|
| CONSULTING FIRMS | 822 | 6240 | 4680<br>8400 | 1680<br>50000 | 7250 | 5700<br>10000 | 2080<br>60000 |
| CONSTRUCTION FIRMS | 199 | 6984 | 5000<br>9600 | 2080<br>30000 | 8700 | 6500<br>12480 | 2600<br>50000 |
| STATE HIGHWAY DEPTS. | 396 | 6426 | 4408<br>8830 | 2100<br>20000 | 7920 | 5520<br>10884 | 2700<br>22800 |
| MUNICIPALITIES & COUNTIES | 493 | 6024 | 4915<br>9767 | 2280<br>19500 | 6995 | 5515<br>9552 | 2916<br>22956 |
| RAILROADS, UTILITIES & INDUSTRIES | 241 | 6996 | 5520<br>9720 | 2676<br>34567 | 8528 | 6666<br>12063 | 3516<br>40148 |
| *EDUCATIONAL INSTITUTIONS | 434 | 6350 | 5270<br>8000 | 3360<br>19000 | 7800 | 6400<br>9700 | 4600<br>18000 |
| **EDUCATIONAL INSTITUTIONS | 434 | 7333 | 6111<br>8922 | 3960<br>19000 | 9040 | 7400<br>11000 | 4557<br>24000 |
| ALL CLASSIFICATIONS (Actual Salaries) | 2585 | 6372 | 4880<br>8865 | 1680<br>50000 | 7630 | 5905<br>10350 | 2080<br>60000 |

*Actual Salaries
**Salaries adjusted to 11-month basis

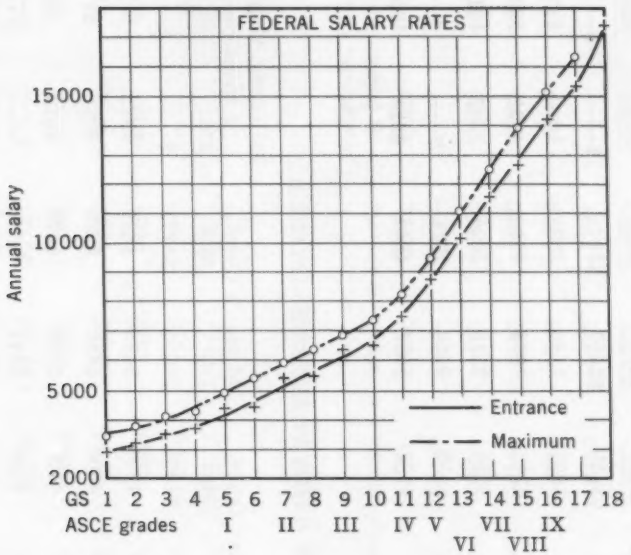
FEDERAL SALARY RATES
Annual salary
15000
10000
5000
2000
Entrance
Maximum
GS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
ASCE grades I II III IV V VI VII VIII IX

Fig. 10

TABLE IX - FEDERAL ANNUAL SALARY RATES
(Classification Act of 1949, as amended March 1955, July 1956, January 1958, and *June 1958)

| ASCE GRADE | FEDERAL GRADE | ENTRANCE | | MAXIMUM | |
|---|---|---|---|---|---|
| | | 1959 Rate | Percent Increase 1957-1959 | 1959 Rate | Percent Increase 1957-1959 |
| | 1 | 2960 | 10 | 3530 | 10 |
| | 2 | 3255 | 10 | 3825 | 10 |
| | 3 | 3495 | 10 | 4065 | 10 |
| | 4 | 3755 | 10 | 4325 | 10 |
| I | 5 | 4490 | 22 | 4940 | 10 |
| | 6 | 4490 | 10 | 5390 | 10 |
| II | 7 | 5430 | 20 | 5880 | 10 |
| | 8 | 5470 | 10 | 6370 | 10 |
| III | 9 | 6285 | 16 | 6885 | 10 |
| | 10 | 6505 | 10 | 7405 | 10 |
| IV | 11 | 7510 | 17 | 8230 | 10 |
| V | 12 | 8810 | 16 | 9530 | 10 |
| VI | 13 | 10130 | 13 | 11090 | 10 |
| VII | 14 | 11595 | 12 | 12555 | 10 |
| VIII | 15 | 12770 | 10 | 13970 | 10 |
| IX | 16 | 14190 | 10 | 15150 | 10 |
| | 17 | 15375 | 10 | 16335 | 12 |
| | 18 | 17500 | 18 | ----- | -- |

*In June, 1958, adjustments were made in the entrance rates for GS Grades 5, 7, 9, 11, 12, 13, and 14. These increases were "for future hiring for certain engineering, scientific and technical positions," according to a directive of the U. S. Civil Service Commission.

NOTE: ASCE Grades A, B and C parallel the old SPS grades, and are roughly equivalent to GS Grades 1 through 6.

TABLE X - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE A

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $2845 | $3466 | $---- | $---- | $2600 | $3302 | $2967 | $3475 | $---- | $---- |
| II | 3115 | 3814 | 3380 | 4420 | 3076 | 3691 | 3180 | 3828 | 4020 | 4778 |
| III | 3000 | 4000 | 3140 | 5000 | 3090 | 4212 | 3658 | 4251 | 4320 | 5031 |
| IV | 2956 | 3466 | ---- | ---- | 2652 | 3318 | 2520 | 3054 | 3502 | 4914 |
| V | 2446 | 3060 | 2520 | 3639 | 2790 | 3450 | 2658 | 3774 | ---- | ---- |
| VI | 3640 | 4620 | 3600 | 5100 | 3360 | 4164 | 3931 | 4944 | 4224 | 4800 |

TABLE XI - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE B

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $3300 | $4000 | $---- | $---- | $3146 | $4004 | $4051 | $4773 | $---- | $---- |
| II | 3900 | 4800 | 4210 | 4970 | 3580 | 4295 | 3828 | 4620 | 4375 | 5734 |
| III | 3620 | 4590 | 4000 | 5800 | 3647 | 4500 | 4420 | 5029 | 4795 | 5310 |
| IV | 3536 | 4000 | ---- | ---- | 3216 | 4170 | 3090 | 4076 | 4212 | 5888 |
| V | 3175 | 4050 | 3060 | 4200 | 3450 | 4200 | 3241 | 4730 | ---- | ---- |
| VI | 4600 | 5400 | 3822 | 5550 | 3900 | 4800 | 5088 | 5574 | 4728 | 5466 |

TABLE XII - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE C

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $4000 | $4200 | $---- | $---- | $3822 | $4888 | $3782 | $4157 | $---- | $---- |
| II | 4800 | 6000 | 4590 | 6000 | 4309 | 5599 | 4482 | 5095 | 5070 | 6648 |
| III | 4500 | 5820 | 4800 | 8400 | 4362 | 5790 | 5069 | 5639 | 5280 | 7260 |
| IV | 3950 | 5550 | 6000 | 7500 | 4020 | 5040 | 4020 | 4800 | 4824 | 6682 |
| V | 4160 | 6000 | 3900 | 5200 | 4110 | 5340 | 3900 | 5712 | ---- | ---- |
| VI | 5200 | 6760 | 5512 | 7320 | 4246 | 5610 | 5418 | 6456 | 5270 | 6492 |

TABLE XIII - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE I

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $4420 | $5824 | $---- | $---- | $4277 | $5167 | $---- | $---- | $---- | $---- |
| II | 4900 | 6000 | 5000 | 6000 | 5029 | 6034 | 4477 | 5695 | 5576 | 7067 |
| III | 5060 | 6000 | 5000 | 6250 | 5280 | 6505 | 5316 | 5970 | 5520 | 6960 |
| IV | 4500 | 5250 | ---- | ---- | 4752 | 5910 | 4290 | 5130 | 5940 | 7245 |
| V | 4800 | 5400 | 5300 | 6250 | 5130 | 6180 | 4752 | 5784 | ---- | ---- |
| VI | 5010 | 6000 | 5400 | 7800 | 5052 | 6132 | 5607 | 6570 | 5940 | 6480 |

TABLE XIV - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE II

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $5480 | $6168 | $4200 | $6000 | $4538 | $5555 | $3650 | $4250 | $5200 | $7000 |
| II | 5550 | 6680 | 5610 | 6760 | 5744 | 7018 | 5210 | 5810 | 6000 | 7607 |
| III | 5832 | 6600 | 5700 | 6900 | 5996 | 7308 | 5902 | 6663 | 6000 | 7608 |
| IV | 5000 | 5500 | ---- | ---- | 5720 | 6720 | 4410 | 5430 | 6282 | 7698 |
| V | 5300 | 5800 | 5250 | 6350 | 5550 | 6792 | 4795 | 6033 | ---- | ---- |
| VI | 5550 | 6675 | 6000 | 7320 | 5760 | 7200 | 6022 | 7185 | 6360 | 6900 |

TABLE XV - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE III

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $5964 | $6910 | $---- | $---- | $5095 | $6474 | $4734 | $5534 | $6000 | $8200 |
| II | 6450 | 7920 | 6000 | 7780 | 6644 | 8306 | 5864 | 6841 | 6750 | 8709 |
| III | 6600 | 7750 | 7350 | 9150 | 6600 | 8322 | 6768 | 7850 | 6480 | 8703 |
| IV | 5460 | 6300 | ---- | ---- | 6290 | 7452 | 5256 | 6420 | 6948 | 8514 |
| V | 5900 | 6800 | 5900 | 7000 | 6060 | 7764 | 5244 | 6600 | ---- | ---- |
| VI | 6525 | 8000 | 6900 | 9600 | 6732 | 8148 | 6540 | 7788 | 6690 | 7746 |

TABLE XVI - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE IV

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $6500 | $7500 | $---- | $ ---- | $6064 | $7725 | $5450 | $6750 | $7200 | $ 9800 |
| II | 7200 | 8840 | 6630 | 8290 | 7369 | 9132 | 6152 | 7272 | 7848 | 10081 |
| III | 7080 | 8360 | 7950 | 9750 | 7632 | 9238 | 7100 | 8830 | 7560 | 10704 |
| IV | 6000 | 7200 | ---- | ---- | 6874 | 7920 | 5496 | 6672 | 7800 | 9720 |
| V | 6300 | 7900 | 6200 | 7000 | 6600 | 8454 | 5514 | 7104 | ---- | ---- |
| VI | 7200 | 9000 | 8250 | 10800 | 7404 | 8988 | 7086 | 8550 | 7020 | 8760 |

TABLE XVII - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE V

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $7280 | $8320 | $---- | $---- | $6812 | $8580 | $6230 | $7530 | $8400 | $11200 |
| II | 8400 | 10100 | 7500 | 9100 | 8494 | 10597 | 6839 | 8352 | 8760 | 11518 |
| III | 7600 | 9000 | 8900 | 12900 | 8400 | 10320 | 8684 | 10244 | 8360 | 12136 |
| IV | 7100 | 8050 | ---- | ---- | 7656 | 9060 | 6912 | 8544 | 8711 | 10272 |
| V | 7350 | 8500 | 7400 | 9250 | 7296 | 9198 | 6120 | 7926 | ---- | ---- |
| VI | 8100 | 10000 | 9600 | 13200 | 8400 | 9144 | 7740 | 9204 | 7500 | 10320 |

## TABLE XVIII - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE VI

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $7800 | $10000 | $---- | $---- | $7618 | $9385 | $6115 | $7315 | $10800 | $14400 |
| II | 9600 | 12000 | 9290 | 12240 | 9405 | 11540 | 7824 | 9552 | 10487 | 14173 |
| III | 8400 | 9600 | 10800 | 14000 | 9061 | 11149 | 9639 | 10419 | 9360 | 15000 |
| IV | 8000 | 9600 | 25000 | 50000 | 8040 | 10080 | 6336 | 7464 | 9900 | 12033 |
| V | 8500 | 9500 | 8200 | 10000 | 8220 | 10584 | 6798 | 8748 | ---- | ---- |
| VI | 9500 | 12000 | 10875 | 14400 | 9660 | 11394 | 8694 | 9594 | 8700 | 12180 |

## TABLE XIX - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE VII

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $8500 | $10428 | $---- | $---- | $8637 | $10352 | $6150 | $6150 | $---- | $---- |
| II | 10800 | 13520 | 9100 | 14000 | 10372 | 12964 | 8874 | 9820 | 11436 | 16620 |
| III | 10000 | 13000 | 14800 | 17250 | 10147 | 12632 | 10046 | 11361 | 11412 | 14050 |
| IV | 9000 | 10200 | ---- | ---- | 9310 | 11250 | 6792 | 7985 | 10750 | 13898 |
| V | 9000 | 11250 | 9800 | 14550 | 8820 | 11412 | 7018 | 9162 | ---- | ---- |
| VI | 10200 | 12000 | 10050 | 12750 | 9984 | 11880 | 9456 | 10716 | 10260 | 12270 |

TABLE XX - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE VIII

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $10940 | $14456 | $---- | $---- | $9922 | $12207 | $6750 | $8310 | $---- | $---- |
| II | 14000 | 16500 | 13500 | 18880 | 11258 | 13508 | 11000 | 12000 | 14772 | 21173 |
| III | 11200 | 14500 | 18000 | 24000 | 12200 | 13800 | 11040 | 13107 | 14000 | 20000 |
| IV | 10200 | 12480 | ---- | ---- | 10170 | 12564 | 7836 | 9540 | 13544 | 17000 |
| V | 10000 | 15000 | 12900 | 18000 | 10254 | 12490 | 7932 | 11046 | ---- | ---- |
| VI | 12000 | 16000 | 15300 | ---- | 10800 | 12840 | 10854 | 12318 | 12540 | 15498 |

TABLE XXI - COMPARISONS OF MEDIAN RATES BY REGIONS - GRADE IX

| Region (See Fig. 1) | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Industries | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $12480 | $15000 | $---- | $---- | $10721 | $12584 | $9381 | $9381 | $---- | $---- |
| II | 15000 | 17000 | 17500 | 25000 | 13508 | 14200 | 12800 | 13350 | 24323 | 31083 |
| III | 18000 | 19600 | 24000 | 30000 | 14000 | 16200 | 13200 | 15979 | 18900 | 24000 |
| IV | 15000 | 20000 | ---- | ---- | 13000 | 14664 | 8346 | 10512 | 20000 | ---- |
| V | 15000 | 20000 | 13200 | 21000 | 12000 | 15540 | 12427 | 14871 | ---- | ---- |
| VI | 15000 | 24000 | 12200 | 18000 | 15000 | 15000 | 14100 | 16860 | 14520 | 16200 |

## TABLE XXII - COMPARISONS OF MEDIAN RATES BY REGION - *EDUCATIONAL INSTITUTIONS

| Region (See Fig. 1) | Instructor | | Asst. Prof. | | Assoc. Prof. | | Professor | | Head of Dept. | | All Grades | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | $5500 | $6380 | $6355 | $7700 | $7309 | $8934 | $9167 | $11000 | $7944 | $11000 | $6930 | $8983 |
| II | 5255 | 6783 | 6599 | 8163 | 7930 | 9400 | 9240 | 11616 | 10389 | 13444 | 7465 | 9438 |
| III | 5500 | 6600 | 6445 | 7944 | 7460 | 9778 | 8984 | 12315 | 9160 | 13027 | 7333 | 9121 |
| IV | 5005 | 6355 | 6325 | 8036 | 7516 | 9289 | 8678 | 10877 | 9901 | 11611 | 7332 | 8861 |
| V | 5500 | 6233 | 6600 | 7944 | 7699 | 8600 | 8800 | 10399 | 10890 | 10945 | 7638 | 8556 |
| VI | 6000 | 6730 | 7333 | 8320 | 8558 | 9280 | 9729 | 11941 | 11000 | 11250 | 7825 | 9254 |

*Salaries adjusted to 11-month basis

## TABLE XXIII - COMPARISONS OF MEDIAN RATES BY REGIONS - ALL GRADES

| Region | Consultants | | Contractors | | Highway Depts. | | Munic. & Count. | | Railroads, Utilities & Indust. | | Educat'l Inst.* | | Educat'l Inst.** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. | Entr. | Max. |
| I | 5928 | 6780 | 4200 | 6000 | 5820 | 7228 | 4922 | 5767 | 7200 | 9800 | 6000 | 7500 | 6930 | 8983 |
| II | 6202 | 7400 | 7000 | 9050 | 6684 | 7924 | 5580 | 6790 | 7425 | 9446 | 6684 | 8500 | 7465 | 9438 |
| III | 6600 | 7800 | 7500 | 9050 | 6600 | 8683 | 6774 | 8065 | 6540 | 7800 | 6350 | 8000 | 7333 | 9121 |
| IV | 5990 | 6600 | 15500 | 28750 | 6432 | 7800 | 4476 | 5610 | 7319 | 8473 | 6000 | 7500 | 7332 | 8861 |
| V | 5800 | 6800 | 5850 | 6750 | 6150 | 7626 | 5082 | 6610 | ---- | ---- | 6000 | 7000 | 7638 | 8556 |
| VI | 7200 | 8400 | 7000 | 8996 | 7044 | 8184 | 6626 | 7838 | 7200 | 8760 | 7000 | 8100 | 7825 | 9254 |

* Actual Salaries
**Salaries Adjusted to 11-month basis

**Salaries Adjusted to 11-month basis

## PROCEEDINGS PAPERS

The technical papers published in the past year are identified by number below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Pipeline (PL), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways and Harbors (WW), divisions. Papers sponsored by the Department of Conditions of Practice are identified by the symbols (PP). For titles and order coupons, refer to the appropriate issue of "Civil Engineering." Beginning with Volume 82 (January 1956) papers were published in Journals of the various Technical Divisions. To locate papers in the Journals, the symbols after the paper number are followed by a numeral designating the issue of a particular Journal in which the paper appeared. For example, Paper 1859 is identified as 1859 (HY7) which indicates that the paper is contained in the seventh issue of the Journal of the Hydraulics Division during 1958.

### VOLUME 84 (1958)

SEPTEMBER: 1750(IR3), 1751(IR3), 1752(IR3), 1753(IR3), 1754(IR3), 1755(ST5), 1756(ST5), 1757(ST5), 1758(ST5), 1759(ST5), 1760(ST5), 1761(ST5), 1762(ST5), 1763(ST5), 1764(ST5), 1765(WW4), 1766(WW4), 1767(WW4), 1768(WW4), 1769(WW4), 1770(WW4), 1771(WW4), 1772(WW4), 1773(WW4), 1774(IR3), 1775(IR3), 1776(SA5), 1777(SA5), 1778(SA5), 1779(SA5), 1780(SA5), 1781(WW4), 1782(SA5), 1783(SA5), 1784(IR3)[c], 1785(WW4)[c], 1786(SA5)[c], 1787(ST5)[c], 1788(IR3), 1789(WW4).

OCTOBER: 1790(EM4), 1791(EM4), 1792(EM4), 1793(EM4), 1794(EM4), 1795(HW3), 1796(HW3), 1797(HW3), 1798(HW3), 1799(HW3), 1800(HW3), 1801(HW3), 1802(HW3), 1803(HW3), 1804(HW3), 1805(HW3), 1806(HY5), 1807(HY5), 1808(HY5), 1809(HY5), 1810(HY5), 1811(HY5), 1812(SM4), 1813(SM4), 1814(ST6), 1815(ST6), 1816(ST6), 1817(ST6), 1818(ST6), 1819(ST6), 1820(ST6), 1821(ST6), 1822(EM4), 1823(PO5), 1824(SM4), 1825(SM4), 1826(SM4), 1827(ST6)[c], 1828(SM4)[c], 1829(HW3)[c], 1830(PO5)[c], 1831(EM4)[c], 1832(HY5)[c].

NOVEMBER: 1833(HY6), 1834(HY6), 1835(SA6), 1836(ST7), 1837(ST7), 1838(ST7), 1839(ST7), 1840(ST7), 1841(ST7), 1842(SU3), 1843(SU3), 1844(SU3), 1845(SU3), 1846(SU3), 1847(SA6), 1848(SA6), 1849(SA6), 1850(SA6), 1851(SA6), 1852(SA6), 1853(SA6), 1854(ST7), 1855(SA6)[c], 1856(HY6)[c], 1857(ST7)[c], 1858(SU3)[c].

DECEMBER: 1859(HY7), 1860(IR4), 1861(IR4), 1862(IR4), 1863(SM5), 1864(SM5), 1865(ST8), 1866(ST8), 1867(ST8), 1868(PP1), 1869(PP1), 1870(PP1), 1871(PP1), 1872(PP1), 1873(WW5), 1874(WW5), 1875(WW5), 1876(WW5), 1877(CP2), 1878(ST8), 1879(ST8), 1880(HY7)[c], 1881(SM5)[c], 1882(ST8)[c], 1883(PP1)[c], 1884(WW5)[c], 1885(CP2)[c], 1886(PO6), 1887(PO6), 1888(PO6), 1889(PO6), 1890(HY7), 1891(PP1).

### VOLUME 85 (1959)

JANUARY: 1892(AT1), 1893(AT1), 1894(EM1), 1895(EM1), 1896(EM1), 1897(EM1), 1898(EM1), 1899(HW1), 1900(HW1), 1901(HY1), 1902(HY1), 1903(HY1), 1904(HY1), 1905(PL1), 1906(PL1), 1907(PL1), 1908(PL1), 1909(ST1), 1910(ST1), 1911(ST1), 1912(ST1), 1913(ST1), 1914(ST1), 1915(ST1), 1916(AT1)[c], 1917(EM1)[c], 1918(HW1)[c], 1919(HY1)[c], 1920(PL1)[c], 1921(SA1)[c], 1922(ST1)[c], 1923(EM1), 1924(HW1), 1925(HW1), 1926(PL1), 1927(HW), 1928(HW1), 1929(SA1), 1930(SA1), 1931(SA1), 1932(SA1).

FEBRUARY: 1933(HY2), 1934(HY2), 1935(HY2), 1936(SM1), 1937(SM1), 1938(ST2), 1939(ST2), 1940(ST2), 1941(ST2), 1942(ST2), 1943(ST2), 1944(ST2), 1945(HY2), 1946(PO1), 1947(PO1), 1948(PO1), 1949(PO1), 1950(HY2)[c], 1951(SM1)[c], 1952(ST2)[c], 1953(PO1)[c], 1954(CO1), 1955(CO1),1956(CO1),1957(CO1), 1958(CO1), 1959(CO1).

MARCH: 1960(HY3), 1961(HY3), 1962(HY3), 1963(IR1), 1964(IR1), 1965(IR1), 1966(IR1), 1967(SA2), 1968(SA2), 1969(ST3), 1970(ST3), 1971(ST3), 1972(ST3), 1973(ST3), 1974(ST3), 1975(ST3), 1976(WW1), 1977(WW1), 1978(WW1), 1979(WW1), 1980(WW1), 1981(WW1), 1982(WW1), 1983(WW1), 1984(SA2), 1985(SA2)[c], 1986(IR1)[c], 1987(WW1)[c], 1988(ST3)[c], 1989(HY3)[c].

APRIL: 1990(EM2), 1991(EM2), 1992(EM2), 1993(HW2), 1994(HY4), 1995(HY4), 1996(HY4), 1997(HY4), 1998(SM2), 1999(SM2), 2000(SM2), 2001(SM2), 2002(ST4), 2003(ST4), 2004(ST4), 2005(ST4), 2006(PO2), 2007(HW2)[c], 2008(EM2)[c], 2009(ST4)[c], 2010(SM2)[c], 2011(SM2)[c], 2012(HY4)[c], 2013(PO2)[c].

MAY: 2014(AT2), 2015(AT2), 2016(AT2), 2017(HY5), 2018(HY5), 2019(HY5), 2020(HY5), 2021(HY5), 2022(HY5), 2023(PL2), 2024(PL2), 2025(PL2), 2026(PP1), 2027(PP1), 2028(PP1), 2029(PP1), 2030(SA3), 2031(SA3), 2032(SA3), 2033(SA3), 2034(ST5), 2035(ST5), 2036(ST5), 2037(ST5), 2038(PL2), 2039(PL2), 2040(AT2)[c], 2041(PL2)[c], 2042(PP1)[c], 2043(ST5)[c], 2044(SA3)[c], 2045(HY5)[c], 2046(PP1), 2047(PP1).

JUNE: 2048(CP1), 2049(CP1), 2050(CP1), 2051(CP1), 2052(CP1), 2053(CP1), 2054(CP1), 2055(CP1), 2056(HY6), 2057(HY6), 2058(HY6), 2059(IR2), 2060(IR2), 2061(PO3), 2062(SM3), 2063(SM3), 2064(SM3), 2065(ST6), 2066(WW2), 2067(WW2), 2068(WW2), 2069(WW2), 2070(WW2), 2071(WW2), 2072(CP1)[c], 2073(IR2)[c], 2074(PO3)[c], 2075(ST6)[c], 2076(HY6)[c], 2077(SM3)[c], 2078(WW2)[c].

JULY: 2079(HY7), 2080(HY7), 2081(HY7), 2082(HY7), 2083(HY7), 2084(HY7), 2085(HY7), 2086(SA4), 2087(SA4), 2088(SA4), 2089(SA4), 2090(SA4), 2091(EM3), 2092(EM3), 2093(EM3), 2094(EM3), 2095(EM3), 2096(EM3), 2097(HY7)[c], 2098(SA4)[c], 2099(EM3)[c], 2100(AT3), 2101(AT3), 2102(AT3), 2103(AT3),2104(AT3), 2105(AT3), 2106(AT3), 2107(AT3), 2108(AT3), 2109(AT3), 2110(AT3), 2111(AT3), 2112(AT3),2113(AT3), 2114(AT3), 2115(AT3), 2116(AT3), 2117(AT3), 2118(AT3), 2119(AT3), 2120(AT3), 2121(AT3),2122(AT3), 2123(AT3), 2124(AT3), 2125(AT3).

AUGUST: 2126(HY8), 2127(HY8), 2128(HY8), 2129(HY8), 2130(PO4), 2131(PO4), 2132(PO4), 2133(PO4),2134(SM4), 2135(SM4), 2136(SM4), 2137(SM4), 2138(HY8)[c], 2139(PO4)[c] 2140(SM4)[c].

SEPTEMBER: 2141(CO2),2142(CO2),2143(CO2),2144(HW3),2145(HW3), 2146(HW3), 2147(HY9), 2148(HY9), 2149(HY9),2150(HY9),2151(IR3), 2152(ST7)[c], 2153(IR3), 2154(IR3), 2155(IR3), 2156(IR3), 2157(IR3), 2158(IR3),2159(IR3),2160(IR3),2161(SA5),2162(SA5),2163(ST7),2164(ST7), 2165(SU1), 2166(SU1),2167(WW3), 2168(WW3), 2169(WW3), 2170(WW3), 2171(WW3), 2172(WW3), 2173(WW3), 2174(WW3), 2175(WW3), 2176(WW3), 2177(WW3), 2178(CO2)[c], 2179(IR3)[c], 2180(HW3)[c], 2181(SA5)[c], 2182(HY9)[c], 2183(SU1)[c], 2184(WW3)[c], 2185(PP2)[c], 2186(ST7)[c], 2187(PP2), 2188(PP2).

c. Discussion of several papers, grouped by divisions.

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